CONVERSATIONS

ON

MINERALOGY.

WITH PLATES,

ENGRAVED BY MR. AND MISS LOWRY,

FROM ORIGINAL DRAWINGS.

IN TWO VOLUMES.

VOL. I.

SECOND EDITION, ENLARGED.

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PREFACE.

AMONG the various branches of Science and Natural History, which are so extensively pursued in this country, not one has made such rapid advances, within a short period, as Mineralogy. Although this Science had been long cultivated, both in Germany and in France, it was still in its infancy, when Natural Philosophy, Chemistry, and Mathematics, had attained a high degree of maturity. It has, however, met with so much encouragement in England during the last twenty years, that besides various Translations from German and French Mineralogical Works, many original Treatises on the subject have been published in this country. Of these, several have been written expressly for the instruction of young persons.

It is several years since the "Conversations on Chemistry" first appeared. The method of communicating knowledge through the medium of conversations appeared particularly well calculated for such works; and that excellent publication, under its unassuming title, exhibits, with an elegant simplicity of style, the most scientific views and most abstruse doctrines of modern Chemistry; and has, perhaps, more than any other work, contributed to disseminate a taste for Chemical science in this country. This opinion is sufficiently confirmed by the number of editions which it has gone through. "Conversations on Chemistry" were followed by "Conversations on Political Economy," and on "Natural Philosophy," by the same Authoress. Introductions to Botany and to Algebra have appeared in the same form; and it is hoped that the present undertaking, on a somewhat similar plan, may not be found unworthy of the attention of the public.

Notwithstanding the number of elementary treatises on Mineralogy which have been published within the last few years, the mode of conversation has not yet been adopted in this branch of Natural History.

It has not been my intention, in the following pages, to enter into minute details, or to support any particular system, but to give my readers clear ideas of the principles of Mineralogy and Crystallography.

With respect to the latter subject, though my observations are founded on the highly ingenious and scientific theory of Haüy, a part of them, and the figures by which they are illustrated, are new; and I feel assured that they will be found useful in explaining facts which it is often difficult for beginners to comprehend. I have said nothing of the system of Crystallography lately introduced by Professor Mohs, for two reasons; firstly, because it is merely a system of description, and does not in any degree explain the structure or formation of Crystals; secondly, because it is so abstruse, that, without entering into it minutely, I fear I could not make it intelligible to my readers; and even were I able to do so, I think they would not find a knowledge of it so practically useful, as that of Haüy's theory.

In my descriptions of Minerals I am aware that there is little novelty; nor can much be expected from the limited plan of the work, since many of the rare Minerals are necessarily passed over almost in silence. I have constantly given a much more diffuse account of the substances which are abundant or useful, than of those which are little known, and, consequently, of limited application; and I have seldom neglected to mention the purposes to which they are applied in the different arts and manufactures, or any other interesting circumstances connected with them.

My classification of Minerals differs in some respects from all that I have seen: but as it is not, to say the least, calculated to perplex the learner more than most other arrangements, I trust it will not be severely criticized. It is, no doubt, as defective as those which I have examined, and rejected because I was dissatisfied with them; for I am far from presuming that I can effect what has hitherto baffled the attempts of the most able Mineralogists; namely, to construct an unexceptionable arrangement of Minerals, founded partly on their chemical properties, and partly on their physical characters. Such systems are however generally allowed to be the most useful to learners; and such an one is therefore adopted.

As it did not appear consistent with the nature of conversations, to particularize all the different synonymes of Minerals, I have inserted the principal in the Index; placing them after the English names. I have avoided as much as possible the use of technical terms in my descriptions; but as a great many (particularly of the German school) have been generally adopted by English Mineralogists, I have endeavoured to define them clearly in the first part of the work; and near the end is an Alphabetical List of nearly two hundred names of Minerals, with their derivations from the Greek, Latin, and German. This catalogue, though far from complete, will be found interesting to the young Mineralogist, for nothing of the kind has hitherto been attempted in our language*. I feel persuaded of its being tolerably correct, as I have been favoured with the assistance of classical friends in the two former languages.

I have great pleasure in acknowledging my obligations to Mr. Phillips (whose "Introduction to Mineralogy," and other publications, are well known and deservedly approved) for his liberality in allowing me to make use of his large collection of original drawings and measurements of crystals. I am likewise much indebted to the politeness of Mr. Mawe, who has frequently gratified me with the use of rare specimens and curious crystals; to Mr. König of the British

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* I understand that a very complete work of this kind has been published *in German* by Professor Mohs, but I am not acquainted with it.

Museum; and to M. Lévy; who have at various times afforded me information.

Having said thus much of the objects and pretensions of these Conversations, it will be manifest that they are intended only to *prepare* the young Mineralogist for the study of more learned treatises. But very little knowledge of Mineralogy can be obtained from books, without an acquaintance with Minerals themselves: this is unquestionably best acquired by personal instruction, which is now easily attainable through the public lectures delivered on this, as well as the other branches of Natural History in London, and in all the Universities and Colleges of Great Britain and Ireland. In London it may also be attained from the private instruction given by Mrs. Lowry, (at her house in Titchfield-Street,) who has for several years devoted a great part of her time to the completion of a very extensive and valuable collection of Minerals. This circumstance, together with her knowledge of other branches of science, renders her lessons at once interesting and advantageous to her pupils; and more particularly so to ladies, who, since their attention has been invited to scientific subjects, by the establishment of public institutions equally fitted for the instruction of both sexes, have cultivated Mineralogy with great ardour.

I would recommend to persons wishing to commence this study a small collection of Minerals, which may be had of Mr. Mawe, 149, Strand, who deals extensively in Minerals and Shells; or of Mr. G. B. Sowerby, of Regent-Street.

Wooden models of Crystals, (such as are occasionaly spoken of in this Work,) are made by Mr. N. J. Larkin, and may be purchased of him at Gee-Street, Somers-Town; or of Mr. Mawe. One or more of the following Books will also be found useful:

Introduction to Mineralogy, by Mr. Phillips, 1 vol. 12mo, 12*s*.

Introduction to Mineralogy, by Mr. Bakewell, 1 vol. 8vo, 1*l*. 1*s*.

Familiar Lessons on Mineralogy, by Mr. Mawe, 1 vol. 12mo, 6*s*.

Manual of Mineralogy, by Mr. Aikin, 1 vol. 12mo.

When some knowledge of the subject is acquired, "A System of Mineralogy," by Professor Jameson, 2d edition, 3 vols. 8vo, 2*l*. 12*s*. 6*d*., will be found of great use; and Allan's "Mineralogical Synonymes."

Mr. Mawe has also written a Treatise on Precious Stones, 1 vol. 8vo.

DELVALLE LOWRY.

DIRECTIONS TO THE BINDER.

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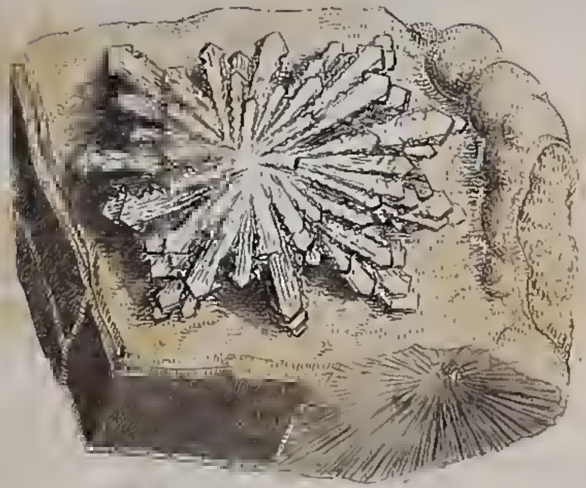
Coarse fibrous Amethyst.


Fibrous Tremolite.


Wavellite.

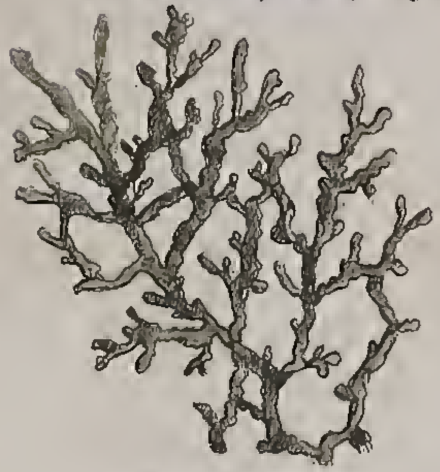

Mammillated Malachite.

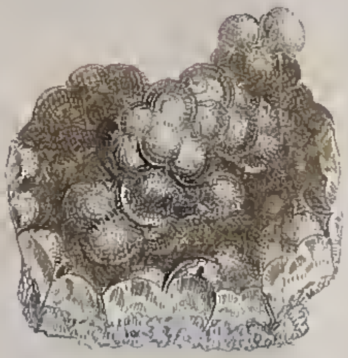

Stellated sulphate of Barytes.


Columnar carbonate of Lead.


Arborescent native Silver.


Arborescent native Copper.


Dendritic native Copper.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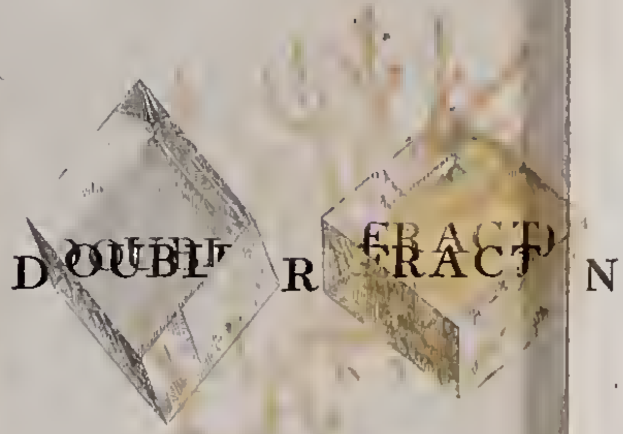
Cellular Quartz.



Carbonate of Lime.

London, Published by Longman, Hurst, Rees, Orme & Brown.

CONVERSATIONS

ON

MINERALOGY.

CONVERSATION I.

MRS. L.

I HOPE you have not been detained by any thing unpleasant, for I expected you earlier.

FRANCES.

Oh no; just the reverse: we have been at the British Museum, and were so much delighted, that we could not resolve to leave it till we found that the time of our appointment with you was past.

MRS. L.

That I can easily imagine:—but what attracted your attention more particularly?

FRANCES.

There is such a variety of interesting objects, that I scarcely know. I was puzzled which to look at first.

MARY.

The minerals appeared to me more curious than any thing else.

MRS. L.

Why so?

MARY.

Because I was told that they were all natural productions—and they are so very beautiful.

MRS. L.

Yes, many of them are. Do you recollect the names of any that you admired?

MARY.

Yes: there are two pedestals of a green stone, called malachite, which perhaps you remember; but I can hardly imagine that they are not artificial.

MRS. L.

I perfectly remember the substance to which you allude: it is a natural production, except that it has been cut into the form of pedestals, and polished; and you will be surprised to hear that the greater part of it is pure copper.

FRANCES.

Pure copper? How very strange!

MRS. L.

I can tell you many things relating to minera logy far more strange than that. Did you not see some diamonds?

MARY.

Yes; beautiful little things, very bright, and all of different forms.

MRS. L.

Well, you will hardly credit me when I tell you that they are nothing more than charcoal.

FRANCES.

How can that be? Diamonds are very scarce and valuable; and charcoal is only burnt wood, which is very cheap.

MRS. L.

True: but though we cannot make diamonds by burning wood, (or in any other way,) we are certain that they *are* charcoal, though not in the state in which we generally see it.

FRANCES.

I do not exactly understand you.

MRS. L.

I will endeavour to explain myself better. Bread is made of flour, yeast, salt and water; yet we are not able to convert a loaf into these ingredients. So, though chemical experiments have proved that diamonds and charcoal are essentially composed of a substance called carbon, chemistry has not discovered any operation by which charcoal may be rendered pure and crystalline. A diamond is supposed by chemists to be carbon in its purest state, and charcoal may be considered as carbon, of which the properties and appearances are altered by the admixture of so very small a portion of some foreign ingredient, that it has never been detected.

MARY.

I understand you perfectly: but can you tell me why all the diamonds at the British Museum are cut into such curious forms? They are not like that in your ring.

MRS. L.

Your question is very natural; but all the diamonds you have seen are in their original state. When minerals are found in regular geometrical or symmetrical forms, they are called crystals. Many of the other minerals that you saw, are crystallized.

FRANCES.

I think I have heard that crystal is a kind of flint; but you say the diamonds are crystals.

MRS. L.

What is commonly called *crystal*, or rock-crystal, is, as you have been told, a kind of flint. It is probably the first substance ever noticed as occurring in a regular form. The antients, on account of its transparency, believed it to be water permanently congealed by extreme cold, and called it Krūstallos, which means *ice;* but, in time, the word was used without attention being paid to its original meaning, and was applied to all the regular figures observed in minerals. At present, a crystal means (properly) a regular and symmetrical solid, produced by nature, or by the operations of chemistry.

MARY.

Is glass a crystallized substance? It is very much like rock-crystal.

MRS. L.

I am afraid you will not readily understand the difference between the crystallization of glass and of the diamond. The particles of substances which crystallize are arranged in a state of perfect regularity; and this must be the case with glass as well as diamonds, otherwise it would not be equally hard, or equally transparent in every part. Common glass does not assume any regular external form; but some particular kinds, cooled very slowly, crystallize in the form of cubes.

FRANCES.

Do all minerals crystallize?

MRS. L.

No: I could tell you the names of a great many minerals which do not; but as you do not understand mineralogy, it would be useless to you to know them. However, if you wish to learn it, I shall be very happy to give you some instruction.

MARY.

I shall be very much obliged to you if you will; for I think I should have been still more delighted with the minerals I have seen, if I had known any thing about the nature of them.

FRANCES.

Is there any difference between mineralogy and geology?

MRS. L.

Yes; you must not confound them. Mineralogy, in its most extensive signification, is the science of the unorganized mass of the globe, and comprehends a knowledge of the chemical, and the physical or external characters of minerals. This knowledge enables us to distinguish one species of mineral from another: geology leads us to explore the mountain masses and beds of stone, of which the crust of the earth is composed; and to examine their peculiar relations and modes of aggregation.

MARY.

Do you mean that the earth is hollow, or filled with water, when you speak of the *crust?*

MRS. L.

No: we know very little of the structure of the interior of the earth below the depth of a mile, which is the perpendicular extent of some of the deepest mines; and compared with the diameter of the earth is not more than the peeling of an apple in comparison with the size of that fruit. The word *crust* is certainly not scientific; but has been generally adopted by geologists, to express that outward part of the earth, with which we are acquainted.

FRANCES.

Then mineralogy and geology are quite distinct from each other?

MRS. L.

They are so; but still they are not independent of each other. Geology cannot be understood without the assistance of mineralogy: for how could you describe granite, slate, or limestone rocks, without knowing those substances? Mineralogy has been called the alphabet of geology; and I think the term is not misapplied.

MARY.

I think I understand the connexion between them. When you have acquired a knowledge of different minerals, you explore the rocks and mines in which they are found, and study their appearance and relative situation in the earth.

MRS. L.

Exactly so.

FRANCES.

It is necessary to understand chemistry also, to be a mineralogist; is it not?

MRS. L.

Yes: for it is chemistry which teaches us the *essential* difference between one mineral and another; that is, the difference of their composition: and without it, mineralogy would be a catalogue of names, which might often be misapplied: the same denomination might be given to two or more minerals very different in their nature, if they resembled each other in appearance; and the same substance, presenting in different specimens a variety of aspects, might receive as many different names. Indeed this has frequently happened.

MARY.

Then it is necessary to analyse every thing before you can give it a proper place in an arrangement?

MRS. L.

Not in the present state of mineralogy; for the greater number of substances that have been once analysed and named, may be distinguished from each other by their external characters. For example: you would never confound an emerald with a piece of marble, or a topaz with the malachite which you saw to-day. On the other hand, a person who was not *well* acquainted with these characters would have some difficulty in detecting a piece of green fluor among several emeralds, being very nearly of the same colour.

FRANCES.

How would you find out the difference between them?

MRS. L.

I would examine the crystallization, if any were visible, or I would try their hardness, if I were allowed to scratch one with the other; the emerald is a great deal harder than fluor, and less heavy. The external characters should be first examined, as it is much more easy to understand them than to analyse a mineral.

MARY.

I do not exactly know what you mean by the external characters of minerals.

MRS. L.

They are those appearances or properties which are discernible without the assistance of chemistry; and *some*, immediately by the senses, as colour, lustre, transparency, weight, taste, flexibility, &c.

FRANCES.

I suppose minerals are *arranged* according to their composition; though they may be often distinguished by their external characters?

MRS. L.

Such a system would be more scientific than any other, could it be rendered perfect, and it has more than once been attempted; but the difficulty of analysing minerals with sufficient accuracy, and others which arise from the imperfection of chemical knowledge, render it at present too difficult to be accomplished; and, perhaps, if it were accomplished, such a system would be, *in general*, less useful than some others; for few persons would take the trouble to become sufficiently good chemists to understand it. Nevertheless, it is desirable that it should be done.

MARY.

In what manner then are minerals generally classed?

MRS. L.

Before I can explain to you intelligibly the nature of classification, you must know something of the substances of which minerals are composed.

MARY.

True. I had forgotten my complete ignorance of the subject.

MRS. L.

Well then, let us begin methodically: perhaps you can define what a mineral is, or what you imagine it to be.

MARY.

A mineral is a stone, is it not? or any thing that is dug out of the earth.

MRS. L.

Your first definition was tolerably correct; your second rather too general, as it includes potatoes and carrots.

FRANCES.

How would *you* describe a mineral?

MRS. L.

To define any thing precisely is very difficult: it is much easier to say what it is *not*. Your sister's definition is much more concise than any which I could give. A mineral seems to differ from animals and vegetables in being completely unorganized; that is, it is inanimate, and possesses none of that construction which is necessary for the support of any kind of existence, or re-production.

MARY.

Minerals do not grow, as animals and vegetables; do they?

MRS. L.

The growth of minerals is a disputed point among naturalists; and Mr. Knight, in his "Theory of the Earth," has published an account of the formation of crystals in basalt by exposure to the air; M. Methuon has written on the growth of crystals of quartz, and of many other substances. But the facts with which we are at present acquainted are too few to enable us to form a theory from them. The presence of water seems to have been necessary in these instances to their formation; and it may be supposed to produce a new arrangement of the particles, which would not take place without it. But you will be better able to understand all this when you know something of crystallography. At present, it is necessary to explain to you the nature and properties of those elementary substances, which, united in different proportions, constitute all the various minerals which are known.

FRANCES.

Are these elementary substances very numerous?

MRS. L.

Compared with the number of minerals which their combinations produce, they are very few.

MARY.

Is not water a simple substance or element?

MRS. L.

No. It is composed of two substances, oxygen and hydrogen; these, with carbon (of which I have already spoken), sulphur, phosphorus, the earths, alkalis, metals, and the bases of some acids, constitute all the minerals with which we are acquainted.

The earths and alkalis have within a few years been discovered to consist of oxygen united to different metals; but as these have never been found in a metallic or pure state, it is more convenient in mineralogy to consider the earths themselves as simple substances.

FRANCES.

I did not know there were more than one kind of earth.

MRS. L.

We are at present acquainted with ten earths, four alkalis, and thirty metals. I will give you a list of their names, with those of the bases of the acids which enter into the composition of minerals; and I advise you to learn them, that I may speak of them the next time I see you.

EARTHS.

Silica.
Alumina.
Lime.
Magnesia.
Zirconia.
Glucina.
Yttria.
Barytes.
Strontian.
Thorina.

ALKALIS.

Soda.
Potash.
Ammonia.
Lithia.

METALS (MALLEABLE).

Platina.
Gold.
Mercury.
Palladium.
Lead.
Silver.
Copper.
Nickel.
Iron.
Tin.
Zinc.
Cadmium.

BRITTLE METALS.

Tungsten.
Iridium.
Rhodium.
Bismuth.
Cobalt.
Manganese.
Molybdena.
Uranium.
Cerium.
Antimony.
Chromium.
Columbium.
Arsenic.
Titanium.
Tellurium.
Osmium.
Selenium.

BASES OF ACIDS.

Fluorine, Chlorine, Nitrogen or Azote.
Boron.
The base of Mellitic Acid.
Sulphur.
Phosphorus.
Carbon.

CONVERSATION II.

MRS. L.

I TRUST you have not found much difficulty in committing to memory the names of mineral substances which I gave you yesterday.

FRANCES.

No; much less than I expected.

MRS. L.

Many of them are, I suppose, entirely new to you; but in a little time you will be as familiar with them as you are with those of silver, copper, and iron. I have already observed to you, that water is composed of oxygen and hydrogen. The former is perhaps the most abundant substance in nature; not only as it is a principal constituent of water, which covers three-fourths of the globe, but also of the earths and alkalis, and it exists in most minerals.

MARY.

Does that marble contain any water?

MRS. L.

No, it does not; but in your favourite malachite water exists in the proportion of about one-tenth of the whole mass. In the most simple state in which oxygen can be procured, it is a gas, or air, and in this form constitutes part of the atmosphere, which would be unfit for respiration without it. Most of the metals are found naturally combined with oxygen, and are then called oxydes. What is commonly called rust of iron is the oxyde of the metal.

FRANCES.

How does the oxygen unite with it?

MRS. L.

The rusting or oxydation of iron is generally occasioned by the dampness of the atmosphere; the small particles of water which are suspended in it are decomposed by the iron, which attracts the oxygen, and the hydrogen is liberated in the form of gas.

MARY.

Is hydrogen found in any thing besides water?

MRS. L.

Yes; united with fluorine, it produces fluoric acid, which is a constituent of Derbyshire spar, or fluor, whence the gas (fluorine) derives its name; those beautiful vases are formed of it: combined with chlorine, it forms muriatic acid, which is abundant in many metallic minerals. Chlorine was formerly called oxymuriatic acid, from the supposition that it contained oxygen. That error is now rectified; and it is called chlorine from its green colour, which is, in Greek, Chlōros.

FRANCES.

What other acids are found in minerals?

MRS. L.

The boracic is one, which is composed of oxygen and boron, a substance not yet decompounded, and of which the nature is not yet entirely known. It is rather a scarce substance; but it is sometimes found nearly pure, in a concrete or solid state, and exists in three or four minerals, combined with earths and alkalis. Mellitic acid, the base of which is not ascertained, has only been discovered in one scarce substance, united to alumina, forming a somewhat combustible mineral.

MARY.

Did not you once tell me that oil of vitriol was an acid?

MRS. L.

Yes. It is a common name for sulphuric acid, which is a compound of sulphur and oxygen, and is very abundant in the mineral kingdom; most of the earths, and occasionally some of the alkalis and metals, are found united with it. The metals are frequently combined with sulphur itself, in a large proportion: most of the Cornish copper ores are sulphurets of copper.

FRANCES.

Sulphuret, I suppose, means something united with sulphur; as oxyde does a substance combined with oxygen.

MRS. L.

Yes, it does; and sulphate, fluate, carbonate, and other words having the same termination, are used to express a substance consisting of an earth, alkali, or metal, and an acid. Sulphur has been considered as a simple substance till lately; it is now suspected to be a compound of hydrogen and something else, which is not yet perfectly known. I need not tell you that sulphur is inflammable; the simple act of lighting a match proves that it is highly so. All the inflammable minerals which are known (except mellite) are composed either of sulphur, or of carbon, and hydrogen, in various proportions.

MARY.

Pray, what is phosphorus?

MRS. L.

It is still more inflammable than sulphur, and is therefore generally kept in water, as it sometimes takes fire when exposed to the air.

FRANCES.

I do not remember seeing any at the Museum.

MRS. L.

It is never found in a pure state, but may be procured from bones, or any other animal matter. It resembles wax in its texture, and is of a pale yellow colour; but it becomes brownish in a short time, by absorbing oxygen from the atmosphere or water in which it remains: when it is dissolved by oxygen, it forms phosphoric acid, and in this state is united with some of the metals and earths.

MARY.

Forming, I suppose, phosphates?

MRS. L.

Yes: it is not plentiful in the mineral kingdom, and has not been discovered in any inflammable mineral.—We shall now speak of the earths. You are already acquainted with the most abundant of them, silica, in the forms of flint and rock-crystal. It constitutes at least one-fourth part of the crust of the globe, being the principal component of granite, porphyry, and sandstone rocks; and many mountains consist entirely of granular quartz, in which rock-crystals are often found. It has never been found in combination with any acid. Alumina is the basis of all clay rocks; and slate, which is an abundant mineral: it also exists in granite and porphyry, though not in so large a proportion as silex. It derives its name from alum, of which it is a necessary constituent; and is also called *argil*, from *argilla*, the Latin word for clay.

FRANCES.

Has lime any other name?

MRS. L.

It has been sometimes called *calx*, which is its Latin name: the word calcareous is derived from it, and is applied to those minerals which consist principally of lime: all marbles and limestones are calcareous, consisting almost entirely of lime and carbonic acid.

MARY.

Is that green marble slab, then, nearly the same substance as the limestone of which houses are built?

MRS. L.

That slab is not marble, but a mineral called serpentine: it contains a large proportion of the earth magnesia, combined with silex, but seldom any lime, except the spots of white marble dispersed through it; and these are not essential to serpentine in general, but distinguish that kind which is commonly known by the name of *verde antico.*

FRANCES.

Magnesia is used as a medicine; is it not?

MRS. L.

Yes: but I do not at present recollect that it is useful in any other way.

MARY.

Are the other earths of great consequence?

MRS. L.

No; very far from it. Barytes, which is the most abundant of them, (though much less so than those I have mentioned to you,) has been occasionally prepared as white paint, and is sometimes useful in chemical operations. Strontian, which derives its name from a town in Scotland, where it was first found, is also used by chemists to detect the presence of carbonic acid, and is occasionally mixed with the other ingredients of fire-works, to produce a pink-coloured light. Zirconia, which is the heaviest of the earths, is very scarce; and has only been found to exist in the hyacinth, which is a precious stone, zirconite, and eudyalite.

FRANCES.

I suppose hyacinths are valuable, as they are so scarce?

MRS. L.

Considered as precious stones, they are not very scarce: great numbers are brought from Ceylon; but the constituent earth, in comparison with silex, lime, or even barytes, is found in a very small proportion. The word *zirconia* is derived from Zircon, meaning *four-cornered**; which is the name given by the Cingalese to the little four-sided crystals of hyacinth which are found in the sand of Ceylon. Glucina was discovered first in emerald, and aqua-marine or beryl, and afterwards in two or three other rare minerals.

MARY.

Has the word glucine any particular signification?

MRS. L.

Yes: it is derived from a Greek adjective, Glūkūs, which means sweet; because, dissolved in acids, it produces sweet salts.

FRANCES.

How can salts be sweet?

MRS. L.

Every compound of an acid, with an earth, alkali,

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* I am indebted for this information to the late Smithson Tennant, Esq.

or metal which is soluble in water, is called, in chemistry, a *salt*, without any regard to the taste it may possess. Alum, which you know is sour, is as much a salt as that you eat at dinner. Yttria, takes its name from Ytterby, in Sweden, where it was first discovered in a very rare mineral called gadolinite; and lately, in some others equally scarce, combined with fluoric acid.

MARY.

There is one more earth, of which you have said nothing yet; thorina.

MRS. L.

It has been discovered so short a time, that its peculiar properties are not yet well known. It appears to differ in some respects from all the other earths, but very much resembles zirconia.

FRANCES.

Do the earths resemble each other much in appearance?

MRS. L.

Yes: when pure they are all perfectly white powders; but some of them may readily be distinguished by their different properties: lime, barytes, and Strontian have a sharp, caustic taste; and, as well as magnesia, partake of the nature of alkalis: for this reason, some chemists have called them alkaline earths. Do you remember whether the earths are simple substances?

MARY.

I think you said that the earths and alkalis were composed of oxygen and different metals, which have never been found pure?

MRS. L.

Very right; they have so great an affinity for oxygen, that when exposed to the air, they burn and are converted into earths or alkalis. They are therefore, when procured, immersed in naphtha, a mineral oil, which does not contain oxygen. *Silicon*, the base of silica, has been thought to resemble boron and carbon more than the metals. *Calcium*, the base of lime, has been procured, but takes fire instantly on exposure to the air, and burns with a brilliant white light; it has therefore been impossible to investigate its nature: very little is known respecting the bases of the other earths; but they are generally supposed to be metals. In this phial, you will perceive some small pieces of a metallic substance, which is potassium, the base of potash.

FRANCES.

I see them very plainly; they appear like silver.

MRS. L.

Take some out with a feather, and throw them into that basin of water.

FRANCES.

What a brilliant light!

MARY.

How very curious, that any thing should burn in water!

MRS. L.

If you drink a little of the water, you will taste the potash, which has been produced and dissolved in it. Sodium and lithium, the bases of soda and lithia, are also too inflammable to be examined minutely: in appearance they resemble potassium. Potash has been found in about fifteen earthy minerals, but in no metallic ones: soda, in not quite so many: and lithia, in two or three very rare substances. Ammonia, in its purest state, is a gas; when diluted with water, (to which it readily unites,) it forms what is commonly termed spirit of hartshorn. It consists of hydrogen and nitrogen.

FRANCES.

Is nitrogen a gas?

MRS. L.

Yes: nitrogen and oxygen are the constituents of our atmosphere; united with a greater proportion of oxygen, it produces nitric acid, which, in the mineral kingdom, is found in saltpetre, or nitrate of potash.

MARY.

Is there not also a vegetable alkali?

MRS. L.

Potash was formerly called vegetable alkali; because it has always been obtained by burning vegetables, in which it is very abundant. The knowledge of its existence in minerals is comparatively recent. Ammonia was also called *animal* alkali; because it is always procured fron animal matter, and *at first*, from the horns of stags and other creatures, whence the name spirits of hartshorn.

FRANCES.

I think I shall easily remember what you have told me about the earths and alkalis; for the names are not all new to me.

MARY.

It is fortunate that the most useful of them are so much more plentiful than the others.

MRS. L.

Your remark proves that you have been attentive to what I have said; and I have no doubt that in a short time you will be very fond of mineralogy, for this is the least interesting part of the study. When I have the pleasure of seeing you again we shall say a little respecting the metals, and I will afterwards introduce you to my cabinet.

CONVERSATION III.

MARY.

I ALWAYS thought that gold was the heaviest metal; but my uncle told me this morning that platina is much heavier;—is it true?

MRS. L.

Perfectly so: gold is about nineteen times as heavy as water, and platina twenty-one times. The weight of substances, compared with the weight of a quantity of water of the same magnitude, is called their specific gravity, and is a very useful character for distinguishing minerals. I should say that the specific gravity of gold was nineteen, and that of platina twenty-one.

FRANCES.

How is that ascertained?

MRS. L.

By a very simple operation, which I will presently explain to you. Weigh the substance, whose specific gravity you wish to ascertain, correctly in air, which should be done in a very delicate balance, like this. (PLATE I. fig. 1.) Then weigh the same body carefully in water; subtract this second weight from the first, and divide the first weight by the difference; the quotient will be the specific gravity.

MARY.

I should like to weigh something in your balance to find out its specific gravity; and if it be a substance which you know, we shall see whether we have done it correctly.

MRS. L.

Very well: here is a piece of topaz; you will find weights in the drawer of the balance, (A,) and a pair of pincers to take up the small ones. The feet of the balance being screws (a, b, c,) you can by means of them, and the spirit levels (C, D,) place it in a perfectly horizontal position.

FRANCES.

The beam is steady now; I will take out the weights.

MARY.

What is the use of these little hooks, Mrs. L.? (d, d.)

MRS. L.

They secure the glass cover, which is put over the balance when it is not in use.

MARY.

It weighs a hundred and seventeen grains.

MRS. L.

It must now be weighed in water.

FRANCES.

Shall I put the scales in water?

MRS. L.

No; that would spoil the instrument, and be of no use. You must take off the scale in which you have weighed the topaz, and in its place hang on this one of silver filigree, which, with the topaz, must be immersed in a jar of water. (fig. 2.)

FRANCES.

Why is that better than the brass scale?

MRS. L.

There are many reasons for preferring this: in the first place, brass is soluble, and by frequent use its weight might, for this reason, be altered. The filigree, being less solid than the brass scale pans, moves up and down more readily in the water; and if it were not made in this form, a little motion in the water might wash out the topaz.

MARY.

It does not weigh so much now it is in the water what is the reason of that?

MRS. L.

It is because water is so much heavier than air, and supports the topaz in some degree. You see it now weighs only eighty-four grains. Subtract this from the first weight, which is to be divided by the difference (33), and the quotient will be the specific gravity.

FRANCES.

The quotient is three and a half.

MRS. L.

You find, then, that topaz is three and a half times as heavy as water.

MARY.

I do not comprehend the reason of this operation.

MRS. L.

I am now going to explain it to you. You saw that when the topaz was immersed in water, it weighed less than it did in air, or, which is the same thing, it lost part of its weight: this loss of weight by immersion in water, in any substance whatever, is always equal to the weight of a quantity of water of the same magnitude as that of the body immersed.

Therefore, if we weigh a body in air, we have its absolute weight, and by subtracting from it its weight in water, we have the absolute weight of an equal bulk of water: by comparing the two, we find the specific gravity of the substance; that is, the ratio of the weight of two bodies of equal magnitude is the ratio of their specific gravity.

FRANCES.

I understand it now, I believe: to ascertain this ratio, you divide the weight of the body by the weight of an equal magnitude of water.

MRS. L.

Exactly so: the specific gravity of water is to the specific gravity of the topaz, as the difference of the weight of the topaz in air and in water, is to the weight of the topaz in air. When the specific gravity of a mineral is spoken of, it is understood to be compared with the specific gravity of distilled water at the temperature of 60 degrees of Fahrenheit's thermometer. A cubic inch of gold is nineteen times as heavy as a cubic inch of distilled water at 60 degrees.

MARY.

I should think this must be a very easy method of determining a mineral.

MRS. L.

It is not difficult, and is sometimes very useful; particularly in determining precious stones, which it would be a pity to scratch in order to try their hardness, and of which the colour and other properties appear to agree with those of another substance. Hydrostatic balances are variously constructed; but you will find this one, which is the invention of Major Kater, the most useful to you, both from its portable size and the ease with which it may be nicely adjusted.

FRANCES.

How do you adjust it?

MRS. L.

By means of these two screws. (e, f,) If any change in the temperature of the atmosphere should cause the two ends of the beam to expand unequally, the equilibrium would be destroyed. You must then, by turning this one, (e,) lengthen or shorten the distance of one scale from the centre. The other screw is used for regulating the centre of gravity of the beam, by raising or depressing one end of it. But let us return to the metals:—platina, which is the heaviest substance in nature except iridium, though not found in great abundance, is useful, as it does not become oxydated by exposure to the atmosphere, and is not destroyed by the intense heat of a furnace; for these reasons, crucibles and other chemical apparatus are made of it.

FRANCES.

My uncle said the touchhole of his gun was made of platina, because it would not rust. But gold does not rust; and why would not it do as well?

MRS. L.

There is no doubt that it would; but platina is cheaper, and therefore preferred. Platina has never been found in combination with sulphur, phosphorus, carbon, or the mineral acids; but is alloyed with small portions of palladium, iridium, rhodium, and osmium. It is so extremely ductile, that Dr. Wollaston has drawn it into wire the $\frac{1}{18750}$th part of an inch in diameter.

MARY.

How could any thing of such extreme thinness be measured?

MRS. L.

That I will explain to you another time, when I tell you how it was drawn to that state of tenuity. Gold is a very beautiful metal; like platina, it has never been found otherwise than in the metallic state, either pure, or alloyed by other metals. Native gold generally contains a portion of silver, and sometimes of tellurium.

FRANCES.

What is a native metal?

MRS. L.

A metal that is found naturally in a metallic state: the ore of platina, though not pure, is always metallic, and therefore called native; but mercury, copper, silver, and most others, are often naturally united with sulphur, carbonic, muriatic, or phosphoric acid, or oxygen, and have not the slightest metallic appearance. The word native is applied also to the earths when they are found in a state of purity.

MARY.

I was very much surprised to see mercury arranged amongst the malleable metals; what is the reason?

MRS. L.

In the fluid state, in which you generally see it, it is neither malleable nor brittle; but mercury is rendered solid by freezing, and may then be flattened or extended by hammering, like gold or silver. The specific gravity of mercury is about 14; that of palladium not quite 12. Lead is more plentiful than any of these metals, and is very useful, as you know.

FRANCES.

Yes; the water-pipes are made of lead, and the frames of casement windows.

MRS. L.

The consumption of lead would be small, were it applied only to those two purposes: but it is extremely useful in the manufacture of glass, colours for painting, and many other articles of commerce; and some preparations of lead are made use of in medicine. When pure, the specific gravity of lead is 11.3.

MARY.

That is light compared with the specific gravity of platina, or even of gold; yet it is very common to say a thing is as heavy as lead.

MRS. L.

When that comparison was first made, platina was unknown, and gold was probably much less in use than at present; lead was most likely the heaviest metal with which people were generally acquainted.

FRANCES.

Is native lead a common substance?

MRS. L.

Lead has been rarely found pure: it occurs in many countries, but almost always mineralized by sulphur, oxygen, or some of the mineral acids. Silver, whose specific gravity is 10, is found in great abundance, both native and in combination with the substances that mineralize mercury and lead. It is ductile, and very tenacious, though not in so high a degree as gold or iron.

MARY.

It is not so useful as lead, I suppose?

MRS. L.

That is only because it is less abundant, and therefore more valuable. Except in operations where lead is indispensably necessary, silver might be used with greater advantage. It might also take the place of copper, and would certainly be very superior to it for all culinary vessels; for copper is soluble in almost every liquid, and in all fat or grease, and is poisonous.

FRANCES.

What is the reason, then, since the teakettle and saucepans are made of copper, that we are not all poisoned?

MRS. L.

Copper is not dissolved by water so readily as to make the use of a copper teakettle dangerous; and the saucepans, which would be quickly corroded by the fat of meat or soup, are lined with tin; so that if they be kept clean, you are in no danger. Very often, however, persons have felt ill a short time after eating green pickles, which is occasioned by the quantity of copper they contain.

MARY.

Why *green* pickles in particular?

MRS. L.

Because it is a common practice (and I have even seen it recommended in cookery books) to put the pickle, as soon as it is made, into a copper vessel, for several hours, that it may acquire a fine green colour; for if copper be dissolved in vinegar, verdigris is produced.

FRANCES.

What a pity that silver is not cheaper, or copper less soluble!

MRS. L.

It has, nevertheless, some advantages over silver: it is harder, more tenacious, and more elastic; and being lighter, is more convenient for utensils in common use: the specific gravity of copper does not exceed 8.

MARY.

Pray what sort of a metal is nickel? I never heard of it till I saw it in the list of metals you gave us.

MRS. L.

Nickel, like iron and cobalt, possesses the remarkable property of being attracted by the magnet.

FRANCES.

Are magnets ever made of it?

MRS. L.

No: it has been said by many good chemists, that nickel is capable of retaining the magnetic power, and of pointing to the north; but others affirm that, like iron, it will only retain that power a very short time.

FRANCES.

What is the reason that magnets are made of iron, if it so soon loses this property?

MRS. L.

Magnets are not made of iron, but of steel, which will retain magnetism for any length of time, and has the power of communicating it to other bars and needles.

MARY.

But is not steel a hard kind of iron?

MRS. L.

Steel is iron hardened by a particular process: it is, in fact, a compound of iron and carbon, or carburet of iron; but as it is artificially produced, and has never been found in nature, it does not properly come under the cognizance of the mineralogist. Iron, which is the most useful, is also the most abundant of the metals; yet it has not been known so long as gold, silver, and copper.

FRANCES.

What can be the reason of that?

MRS. L.

Probably because it is not so easily obtained in a state of purity: for native iron, which has but lately been known, occurs in very small quantity; and the process of reducing it from the ore is tedious and complicated: but gold has been found ever since the earliest ages in a state of purity, or alloyed by very small quantities of other metals: silver and copper are often found native, and their ores are easily worked. The utility of iron, whether in the form of iron or of steel, is so well known, and the uses to which it is applied are so numerous, that it would be impossible and unnecessary to enumerate them. One of its best properties is its extreme tenacity: an iron wire, one-tenth of an inch in thickness, will support 705 pounds, without breaking. It has the advantage also of not being heavy, its specific gravity varying from 7.6 to 7.8. Tin is a useful metal, and rather lighter than iron: its specific gravity is 7.2.

MARY.

Is not tin very soft?

MRS. L.

Yes; it is very little harder than lead, which is the softest of all the metals.* Tin is found both in the state of an oxyde and of a sulphuret; but has not yet been discovered native. It is but a few years since zinc was first arranged with the malleable metals; for it is brittle, except when heated to a particular degree of temperature; but in this state it may be hammered or rolled into thin plates: and it is remarkable that this is nearly the degree of heat at which brass is most brittle. Brass is a combination of zinc and copper.

FRANCES.

I was surprised at not finding brass enumerated among the metals, and thought you had forgotten it. I suppose it is an artificial production, which does not occur in mineralogy?

MRS. L.

No ore of brass has been found hitherto; but

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* Except the metals which are the bases of the earths and alkalis.

it may perhaps exist. The ores of zinc are sulphurets, carbonates, and silicates. In the carbonate of zinc of Derbyshire, cadmium has been found: it was first observed in an ore of zinc from Silesia, but very little is known respecting its properties. All these metals possess the important property of malleability: gold, in the highest degree; one grain of it, when beaten out to its utmost extent, will cover 56 square inches: it is then called gold leaf.

MARY.

How extremely thin it must be! I wonder if it could be made so thin as to become transparent?

MRS. L.

If you hold a piece of gold leaf before a strong light, it appears of a green colour: silver leaf transmits a white light; and it is probable that all the other metals would be, in some degree, transparent, if they were reduced to a state of sufficient tenuity. Iridium, which is the heaviest of the brittle metals, very much resembles platina in appearance. When perfectly pure, its specific gravity is 23.

FRANCES.

Are all the brittle metals heavy?

MRS. L.

No: one of them, chrome, is lighter than any of the malleable ones. The specific gravity of chrome is 5.9.

MARY.

The brittle metals are of very trifling importance, I should think, compared with the malleable ones.

MRS. L.

They are, of course, inferior in real utility (in general); but some of them are useful, and many very ornamental: for instance, a very fine yellow colour is prepared from chrome, which is much valued by artists. Cobalt is the basis of the beautiful blue colour called smalt, and of the blue which is used for printing on porcelain. Antimony is of still greater importance; it is an efficacious medicine, and enters into the composition of type metal; besides which, Naples yellow is made from it.

MARY.

But, pray, how are all these things made? I am quite anxious to know; for I seem to have been perfectly ignorant of a great many substances, with which people in general must be very well acquainted.

MRS. L.

I am not surprised at your curiosity, my dear Mary, and had almost anticipated your questions; but you must excuse me from answering them at present. I wish to make you slightly acquainted with the nature of these bodies previously to your studying mineralogy; but if you wish to know all their properties, their combinations, and their uses, you must study chemistry.

MARY.

I should like to begin directly.

FRANCES.

So should I—that is, if you think it will not interfere with mineralogy.

MRS. L.

On the contrary, you will find it very advantageous to you in your present pursuit. I am sorry that I am not sufficiently at leisure to give you some instruction myself in chemistry; but if you have a book and a little apparatus, your brother will, I dare say, give you some assistance.

FRANCES.

And what book would you recommend to us?

MRS. L.

The best introductory book that I know of is the "Conversations on Chemistry." It was written purposely for young persons; and in so clear and perspicuous a manner, that I think you will have little difficulty in understanding it. But I must beg you to attend to the metals this morning, that we may not have to resume the subject to-morrow. Cobalt, of which I have just spoken, is of a light grey colour with a shade of red, and rather soft, though brittle: its specific gravity is 8.5. It attracts the magnet, and may be converted into a magnet, like steel. It has never been found pure; but is mostly combined with arsenic and sulphur.

MARY.

Is not arsenic poisonous?

MRS. L.

So much so, that when thrown on hot coals the fumes are very injurious to any one who smells much of them. Arsenic is often found in a native state, and nearly pure: it is of a blueish-white colour, like antimony, but becomes tarnished by exposure to the air in a very short time. Native tungsten has never been discovered; but when rendered pure, by chemical operations, it appears of a light steel grey colour. It occurs in the state of an acid, united with iron and with lime.

FRANCES.

I do not understand how a metal can exist in the state of an acid.

MRS. L.

When sulphur is united to a sufficient proportion of oxygen, sulphuric acid is produced; and in the same manner tungsten, arsenic, chrome, and molybdena become acids. In this state they are found combined with several other metals, forming tungstates, arseniates, chromates, and molybdates: these four have been sometimes called semimetals. Rhodium is one of the four metals which exist in the ore of platina. Its specific gravity is 11, which is nearly that of lead; it derives its name from rhŏdŏn, the Greek word for a rose, on account of the red colour of its salts: osmium is another of these metals, so called from ŏsmē (odour), from the aromatic smell which its salts possess. None of these have been applied to any useful purpose, nor is it likely that they ever will be, as they are very rare and very brittle. Manganese, in a metallic state, cannot be used, for it becomes oxydated immediately after it is procured. One of the uses of its ores is to give a purple tinge to glass.

MARY.

I have often observed glass windows, that appeared of a lilac colour, when seen before a white curtain or shutter:—is that owing to manganese?

MRS. L.

Yes, it is. The specific gravity of manganese is 8.

MARY.

Is tellurium a native metal?

MRS. L.

Yes; but it generally contains from 1 to 30 per cent of gold. Titanium is a scarce metal, of which oxydes and silicates only have been found, some of them containing iron; and it exists in some iron ores. It is very difficult, almost impossible, to reduce it to the metallic state. Cerium and columbium are still more scarce; and for the same reasons their specific gravity is still unknown. Uranium is found in the state of an oxyde; it has been reduced to a metallic state, but with great difficulty, and appears to be very brittle, and granular in its texture. Its specific gravity is about 6. Bismuth has been occasionally found native: it is not an abundant metal, but is used with lead and tin, to make fusible metal.

FRANCES.

Are not all metals fusible in some degree?

MRS. L.

Yes, they are; but this alloy is so called, because it is so very easily melted; a heat rather less than that of boiling water being sufficient. It is used by diamond cutters to fix their diamonds in. I believe bismuth has been prepared for medicine; but certainly in very small quantities.

You have now acquired some idea of all these simple substances in their pure and uncompounded state. You will soon see them united together in various proportions, and presenting a great variety of appearances. Many of the metals are *necessary* to mankind in a civilised state; others are considered useful and ornamental; and some are, at present, merely objects of curiosity.

MARY.

Iron is of course the most useful and necessary: but which do you think deserves the second place?

MRS. L.

In England, I believe, copper is of the greatest utility after iron; but if all metals were equally abundant and cheap, silver would most probably precede it.

FRANCES.

Why not gold or platina, since they are still less liable to be injured by liquids?

MRS. L.

This advantage would be counterbalanced by their great specific gravity, which would be very inconvenient in the utensils made of them. Tin would be preferable to silver for some purposes, even supposing them equally plentiful; because it is much lighter. Palladium, if found in sufficient quantity, would perhaps be useful from its uncommon hardness. I am now going to propose that you should have some knowledge of the external characters of minerals before you examine my collection; for, as I do not undertake to teach you chemistry, I wish you to understand these characters well. There are some chemical characters, however, which are very useful, and very easily examined; such as the action of acids, and of the blow-pipe; and these I shall explain to you.

FRANCES.

Though I am sure that you are giving us the best possible advice, I cannot help feeling some disappointment at being obliged to delay, even for a day, the pleasure of peeping into your cabinet. I hope the study of these external characters will not detain us very long.

MRS. L.

You need not be afraid that they will tire you: if I am not mistaken, you will find crystallography as interesting as it is useful; and you will see many specimens in which I must show you the particular characters which distinguish them and the other minerals, which possess the same. Properly speaking, these should be called *physical* characters; but, in general, that term is applied only to three, which indeed cannot with propriety be called external; they are, magnetism, electricity, and phosphorescence. But I will give you a list of all the *principal* physical characters; some mineralogists make numerous subdivisions in all of these; but I shall trouble you with them as little as possible; for I think *great minuteness* as puzzling to a learner as it is fatiguing.

Colour.
Form.
Lustre.
Transparency.
Hardness.
Flexibility.
Frangibility.
Weight.
Taste.
Smell.

—

Magnetism.
Electricity.
Phosphorescence.

CONVERSATION IV.

MARY.

I SUPPOSE we shall find colour the most useful of the external characters, as you have placed it at the head of the list?

MRS. L.

It is placed there because it is at first the most *striking* character, rather than on account of its superior utility.

FRANCES.

It must be very useful, however; for this alone would enable me to distinguish many substances from each other.

MRS. L.

There are few minerals that can be determined by *one* of their external characters alone; but I should like to know in what instances you think colour sufficiently distinctive?

FRANCES.

My dear Mrs. L., could any one be so stupid as to mistake a sapphire for a ruby or a topaz?

MRS. L.

Why not?

FRANCES.

Because sapphire is blue, ruby red, and topaz yellow: I wonder you should not have thought of that.

MRS. L.

But if I were to show you red and yellow sapphires, how would you distinguish them from the ruby and topaz?

FRANCES.

I am afraid I should not perceive any difference between them; but I thought sapphires were always blue.

MRS. L.

You could not have chosen a more unfortunate example to support your opinion. Sapphires are found white, blue, purple, red, green, yellow, and grey: topaz is also very various in its colour; you have seen *white* topazes, as well as yellow ones; they are sold and worn under the name of nuova minas: pale blue and green ones are not uncommon; and they are sometimes found of a fine red colour.

MARY.

I am quite disappointed to hear that the colours of the same mineral are so various. I shall take care not to depend so much on this as on the other characters.

MRS. L.

In that you may perhaps be right; but I have not said that to pay attention to the colours of minerals is as useless as you now seem to imagine: I wished to show you that you must not depend on colour *alone*, to distinguish one mineral from another. It is of great importance, when you have seen enough to be able to observe the very slight shades, which are often the only apparent difference between two specimens. Here are two which you would perhaps think the same substance.

MARY.

I should indeed.

FRANCES.

They are both green, at least.

MRS. L.

And both fibrous; but do you perceive no difference in the colour?

MARY.

I think the colour of this is a little yellower than the other; but I see very little difference.

MRS. L.

That shade which appears to you so trifling is to me very perceptible, and would satisfy me that this was epidote, and the other, actinolite. But nothing can be learnt without practice; you could not net the first time you tried, because your fingers wanted practice in that kind of work; and now your eye wants practice before it can distinguish minute differences of colour. I would therefore recommend you to attend to the colours of minerals, without placing too much dependence on them at first; and I will point them out whenever they are characteristic of any substance. You will perceive in some minerals changeable colours, which cannot be said to belong essentially to them, and are sometimes accidental, such as the brilliant sparks and flashes in opal, and fire-marble.

FRANCES.

But are not those flashes of light the real colours of opal? I never saw any without them.

MRS. L.

That is because you have probably seen none but *precious* opal, which is the only one of the species in which they occur; and on that account is the only kind which is used for ornamental purposes. Those brilliant reflections are produced by numerous very small cracks, which exist naturally in precious opal: the real colour of it is generally blueish or yellowish white. In many other minerals, iridescent colours arise from accidental causes, and sometimes appear on the surface, as in sulphuret of antimony.

MARY.

What is the meaning of iridescent?

MRS. L.

The word is derived from *iris*, the Latin name for the rainbow, and signifies the arrangement of colours in concentric circular stripes*; because

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* It is sometimes used to express colours arranged in *straight* parallel stripes.

they resemble the rainbow. I do not think it necessary to say more on this subject at present; it will be better understood by examining and comparing together, real specimens. Regular form is perhaps the most important external character of minerals, and may vie with chemical analysis, as a test of their composition; yet it does not strike the eye so immediately as colour.

FRANCES.

I hope minerals are less various in their form than in their colours; or I believe that I shall find mineralogy very perplexing.

MRS. L.

I am sorry to see you so ready to anticipate difficulties, Frances: but I beg you will not imagine crystallography difficult till you find it so (which I trust you will not); for the crystallization of minerals is one of their most constant and invariable characters.

MARY.

Does every mineral then crystallize differently?

MRS. L.

No; that is not exactly the case: some few regular forms are common to several substances; and most minerals present great variety in their crystallization. I have selected some wooden models, as well as natural crystals, which will enable you more readily to comprehend what I intend to say on the subject, than drawings, or explanation alone. You will find your knowledge of the elements of geometry very useful, as all crystals, even the most complex, are derived from simple geometrical solids.

FRANCES.

I do not know whether I understand properly what you mean by *deriving* one form from another?

MRS. L.

I will explain to you by some examples. Look at these crystals of carbonate of lime (PLATES VI. and VII. figs. 168 to 205.); they are very numerous, and apparently dissimilar; yet they all have some relation to one particular figure, from which they are said to be derived. This figure is called the *primitive form.*

MARY.

I do not indeed see much resemblance between these crystals, except in a few specimens: here is one (fig. 3.) something like the summit of the one in your hand (fig. 7.).

MRS. L.

But here is one (fig. 11.) very unlike both of them.

MARY.

I should never have supposed that the same substance appeared in such different forms; I do not see the least similarity between them.

MRS. L.

Let us look at the models;—Here is one of that which you first took up: it is an obtuse rhomb, the primitive form of carbonate of lime (fig. 3.).

FRANCES.

Is it not a parallelopipedon?

MRS. L.

Yes; but when all the faces of a parallelopipedon are equal and similar rhombuses, it is called a rhomb: Besides, we generally consider a parallelopipedon as standing upon one of its faces; but a rhomb appears most symmetrical when standing on one of its summits, and is always represented in that position, the axis being vertical. You see the summits A, and S, differ from the other solid angles, in being formed by the meeting of three equal plane angles; the others are formed by two acute, and one obtuse, plane angle. Now we will suppose such a rhomb of carbonate of lime to consist of rhombic particles; that is, of minute rhombs similar to itself, which you will easily understand by examining this model (fig. 3.). If you divide it parallel to the face A D E F, you will reduce it to thin rhombic plates or laminæ (fig. 4.): if again you divide it parallel to the face C D E S, you will obtain long thin rhombic prisms, such as these (fig. 5.): finally, by cutting it in a third direction parallel to the face A B C D, these prisms may be subdivided into little rhombs (fig. 6.), which will be in every respect similar to the original one.

MARY.

I see clearly that a *wooden* rhomb may thus consist of smaller ones: but how can we be sure that this is the case with a crystal of carbonate of lime?

MRS. L.

By breaking or splitting a piece, you will find that all the fragments are either rhombs, rhombic prisms, or rhombic laminæ; and these forms can be obtained from every crystal of this substance. If you split off plates of equal thickness from every face of the rhomb, you will lessen it, but without altering its form; it is the most simple of all the crystals in which carbonate of lime occurs, and on that account is considered as the primitive.

If you examine this model (fig. 8.), you will see how the figure is derived from the primitive by the deposition of laminæ on its faces. When you have removed those little caps, or shells, you will see the primitive rhomb.

FRANCES.

How very curious!

MARY.

And is it in this manner that crystals grow from one form to another?

MRS. L.

Of that we cannot be quite certain; but we shall suppose it to be the case at present: if this does not explain the manner in which crystals are produced, yet it is very convenient for elucidating their structure.

FRANCES.

But could I split off such shells of carbonate of lime from this crystal (fig. 7.), and find the primitive rhomb in the middle of it?

MRS. L.

You would obtain the primitive rhomb by separating laminæ from either end of the crystal, parallel to its three terminal faces.

You perceive that the laminæ which are placed on this rhomb (fig. 8.) do not reach the edge of it.

FRANCES.

No; it appears as if a row of little rhombs were left out.

MRS. L.

The same thing has taken place with regard to the other laminæ, for you see they do not extend to the edges of those on which they rest; a row of particles has been subtracted from each of them. This apparent decrease of the laminæ is called *decrement*. In this we have an example of decrement on what are called the lower edges of the rhomb. B C, C D, D E, E F, (fig. 3.).

MARY.

Why do you say *apparent* decrease?

MRS. L.

Because, in reality, there is no decrease at all: the laminæ which touch the rhomb are no larger than those which are furthest from it; and the crystal itself is evidently *increased* by every successive lamina which is deposited on it. In this solid (fig. 9.) the laminæ extend *beyond* the edges ab, bc, cd, &c. of the rhomb, while a decrement takes place on the upper edges Aa, Ac, Ae. It is by means of these decrements of the laminæ, which are deposited on the primitive rhomb, that new crystals are produced, and are said to be derived from it. In both these examples the laminæ are supposed to be of the thickness of one particle, and a row of the breadth of one particle is subtracted each time: these are called simple decrements.

FRANCES.

There are other kinds of decrement then?

MRS. L.

Yes; in some cases the laminæ are of the thickness of one particle, whilst two, three, or more ranges are subtracted in breadth; in others, a single row of particles is subtracted from laminæ of the thickness of two or more particles: these are called mixed decrements, and the two kinds are distinguished into decrements in breadth and decrements in height. Can you imagine, Mary, what would be the effect of a decrement in breadth, in place of a simple decrement on the lower edges of the rhomb?

MARY.

Let me see—The planes formed by the edges of these laminæ are upright (fig. 8.), and those on opposite sides of each edge, form but one: but if they receded from the edges of the rhomb by greater subtractions in width, they would incline towards the axis, and two planes would be formed, one above and one below every edge, making an angle with each other—would there not?

MRS. L.

Yes; you have described it very well: but as here are several crystals produced by similar decrements, try if you can find one; and I shall more easily know if you yourself understand what you have said.

MARY.

I think this one must be produced by such a decrement (fig. 10.).

MRS. L.

You are right—That solid is the effect of a decrement of two ranges in breadth; it is a triangular dodecahedron, a very common form of carbonate of lime. The other crystal (fig. 9.) is called the equiaxe rhomb; because, though much larger than the primitive, its axis is of the same length. There are other dodecahedrons produced by mixed decrements, one of them by a decrement of three in breadth to two in height.

FRANCES.

That would be more obtuse, I suppose?

MRS. L.

On the contrary, it would be more acute than this; when the laminæ decrease by *one range*, a prism is formed, or, if you please, a pyramid, whose axis is infinite; when the axis is shortened, the pyramid is of course more obtuse. But the ratio of 3 to 2 does not differ so much from the ratio 1 to 1 as

2 to 1 does, which is the decrement producing that particular dodecahedron (fig. 10.) called by Haüy, the metastatic.

FRANCES.

I see now: if the decrement were very rapid, by several ranges in breadth, the two new planes would almost coincide with the faces of the primitive.

MRS. L.

Certainly; they would. Now let us see what would be the effect of a decrement in breadth on the *upper edges* Aa, Ac, Ae (fig. 9.), instead of the simple decrement which produced the equiaxe.

FRANCES.

The two triangular planes, A *x y*, A *y z*, which form but one continued face in the equiaxe rhomb, would incline more on the face Aabc, and Acde, making an angle on the edge Ac, &c.—we should have then six planes instead of three.

MRS. L.

Or twelve instead of six; the new crystal would be an obtuse scalene dodecahedron.

MARY.

I thought there were but two kinds of dodecahedron, the pentagonal and the rhomboidal.

MRS. L.

Every solid bounded by twelve planes is a dodecahedron; this would be a triangular one.

I will show you one more example of decrement on the edges, and that in a crystal which is not a rhomb (fig. 12.). It is a rhomboidal dodecahedron derived from a cube.

FRANCES.

Yes; by a simple decrement.

MARY.

That is very easy to understand. Are all rhomboidal dodecahedrons produced in this manner?

MRS. L.

No; it is the primitive crystal of some substances, and in others it is derived from the octahedron.

MARY.

That is very curious.

MRS. L.

The laminæ are, in this case, square; when derived from the octahedron, triangular (fig. 13.). You see that, in this case also, the decrement is simple, otherwise a twenty-four sided solid would result.

FRANCES.

Yes; for, at present, the two adjoining planes form but one, as in the equiaxe rhomb.

MRS. L.

Other modifications are produced by decrements round the *solid angles* of the primitive crystals. One of the simplest examples of this is the formation of the flat summit of the hexagonal prism:—

you see that where only *one* decrement has taken place (fig. 7.), and that parallel to the lower edges of the rhomb, the summit of the secondary crystal resembles the primitive; but in this solid (fig. 11.) each summit is a single plane. Have you any idea how such a plane could arise from a decrement round the summit of the rhomb?

FRANCES.

Not the least at present; I should have thought that could only be formed by a successive deposition of hexagonal laminæ one above the other.

MRS. L.

Suppose, in place of three complete rhombic laminæ which we have imagined to be deposited on the upper surface of the rhomb, that a particle be subtracted from each of them at the upper angle; instead of covering the summit of the primitive, you would see as much of it as one of those particles. Perhaps you will understand this better with the assistance of some models. The particles are subtracted from the laminæ, in rows, parallel to the diagonal A B (fig. 14.). The first row contains but one particle, the second two, the third three, and so on. This model (fig. 15.) represents a rhomb, and three superimposed laminæ, each diminished by one row of particles.

MARY.

Surely more than three particles have been subtracted here?

FRANCES.

I think there are six wanted to surround the summit completely.

MRS. L.

Your observation is correct; but you will see the necessity of this subtraction, if you consider that the laminæ extend *beyond* the upper edges of the rhomb, in order to prevent the formation of re-entering angles. If the laminæ were not thus extended, a channel would be formed along each of the upper edges.

FRANCES.

I believe I understand the reason of it. There is but one particle subtracted from each lamina, considering them of the same size as the faces of the rhomb; and the channels are filled by as many particles as are necessary to form a line from *a* to *b*.

MRS. L.

Exactly so.

MARY.

But why should there not be a channel on the upper edges as well as the lower ones? or why are there any in these models, for I see none in the real crystals.

MRS. L.

You have spoken without thinking, Mary, or you would not have asked that question. The particles of which substances are composed are indefinitely small, and the channels which they form on the faces of secondary crystals are imperceptible; therefore they appear like perfect planes: but if the laminæ did not reach beyond the *upper edges* of the rhomb, the channel would increase with every successive deposition, and the result would be such a solid as this (fig. 16.).

You see that a simple decrement round a solid angle, as well as on an edge, produces a single plane (fig. 15*.). Now suppose that a *decrement in breadth* were to take place around the summit of the rhomb, what would happen?

FRANCES.

There would be three planes around the summit instead of one.

MRS. L.

But tell me how they would be situated: I suppose the ranges of particles subtracted in the same direction as in fig. 15.

FRANCES.

They would incline from the summit, on the faces of the primitive, and the prism would appear like fig. 8., except that the summit would be more obtuse.

MRS. L.

Well, that is correct: but suppose that no other decrement took place but this, and that it were to attain its limit—what would be the consequence?

MARY.

Stop—I think I know: it would be an obtuse rhomb—more obtuse than the primitive.

MRS. L.

I am very glad that you have a clear idea of it, for it is a transformation not very easy to comprehend. Here is a model of it, exhibiting the laminæ, by means of which it has been derived from the primitive (fig. 17.). It is more obtuse than the equiaxe, and a decrement of 3 to 2, instead of 2 to 1, would have produced one still more so, because the ratio is nearer to that of 1 to 1, which produces a plane. As you seem to understand the nature of simple and mixed decrements, both on the edges and angles, I shall not detain you with them any longer; but there is another kind with which you ought to be acquainted before we leave the subject of crystallography.

FRANCES.

Can decrement then take place on any other part of a crystal than the edges and angles?

MRS. L.

Certainly not—but we may imagine the particles to be subtracted in an order very different from that in which we have seen them in these examples. Decrements on the edges are produced by a subtraction parallel to those edges; decrements round the angles are the effect of subtraction in the direction of the diagonals; but, in intermediary decrements, the particles are subtracted in the direction of a line which is intermediate between the diagonal and the side. This figure (fig. 18.) will render it more intelligible to you,—it represents a cube, and the side is supposed to contain twelve particles. The lines *ap*, *bq*, *cr*, are parallel to the diagonal, and are also the diagonals of the bases of the particles. The lines *aq*, *bs*, *cu*, are intermediate between the diagonal B C, and the side A C; now these lines are the diagonals of the rectangles *A a h q*, *a b i h*, &c., or of the bases of the molecules * subtracted, each consisting of two cubic particles.

MARY.

I cannot very easily represent to myself the *appearance* of such a decrement, though I believe I understand what you mean.

MRS. L.

Perhaps this model (fig. 19.), though not made to explain the particular case of which I have spoken, will give you a better idea of it.

MARY.

I see that the molecules here subtracted, each consists of six cubic ones, instead of two as in the case you mentioned.

MRS. L.

Observe that, in order to produce but *one* plane on the angle A, the molecules are subtracted in a different order on each of the three contiguous faces. The laminæ, deposited on the upper surface A B D C (figs. 18. and 19.) are of the thickness of three cubic particles, and the subtraction is, by one particle, in the direction A C, and by

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* Sometimes called the subtractive molecule.

two in the direction A B. But the laminæ, applied to the face A F G C, are equal to two particles in thickness, while one is subtracted parallel to A C, and three parallel to A F. You will see this better by altering the position of the model, and considering A F G C as the upper face. The thickness of the laminæ is in the direction of the edge A B.

FRANCES.

And the thickness of the laminæ, on the plane A B E F, is equal to one particle in the direction A C.

MRS. L.

And in what order would the decrement take place on those faces, supposing that two particles were subtracted from the laminæ on the upper plane along the edge A B?

FRANCES.

Let me see—The thickness of the laminæ, on the plane A B E F, must be in the direction A C, and therefore equal to one particle;—two would be subtracted along A B, as in those on the upper face. The laminæ, on the face A C G F, would be equal to two particles in thickness, but the molecules would be of the length and breadth of one.

MRS. L.

Very right—You see that on the plane A C G F the decrement is not intermediary; but a decrement in height. The example which I have made use of to explain these decrements to you, does not exist in nature, but I have chosen it because it was the simplest I could think of. Though intermediary decrements frequently occur in the cube and other platonic solids*, they never take place in the manner represented by this model.

MARY.

How then?

MRS. L.

The laminæ, on each face, are of the same thickness, and the particles are subtracted in symmetrical order with regard to the solid angle round which the new planes are produced. A single face would result from this decrement (fig. 19.), and the solid would be represented by fig. 20., where the angle A appears to be replaced by the face *b r a*. This replacement of an angle or an edge by *one* plane, is called truncation, because it has the appearance of having been cut off: we know that this never happens in nature, but the expression is very convenient. If the decrement along the edge A B were similar to that along A C, we should have a plane on each, as represented by fig. 21.; and we may easily imagine, if the same thing were to happen with regard to the other faces, that six planes would result. I am not sure that I have rendered it quite intelligible to you.

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* The platonic solids are the tetrahedron, the cube, the octahedron, the pentagonal dodecahedron or pentahedron, and the icosahedron.

MARY.

O, perfectly so—I comprehend it very well.

FRANCES.

It appears so simple, that I think I could draw it.

MRS. L.

Pray do so; you cannot give me a better proof of having understood me.

FRANCES.

Well, there is a sketch of it, Mrs. L. (fig. 22.): is it correct?

MRS. L.

Yes; it is very well done. When an angle appears to be replaced in this manner (by more than two planes), it is said to be acuminated: the expression is not very correct, however, as the word, which is derived from a Latin one, signifies *sharpened*; but it is correctly used to express the replacement of a *plane* by several faces, as a solid angle is produced in this case. When an angle or edge appears to be replaced by *two planes*, we say they are bevelled: in all these cases we call the new planes the truncating, bevelling, or acuminating planes, according to their number. I am glad you can draw these things; but I should like you to make a few models also.

MARY.

But, my dear Mrs. L., how can we do that? we have no saw, no planes, or chisels.

MRS. L.

There are many substances which may be cut without the assistance of any of these: for example, raw potatoe or turnip; or, if you dislike these, you will find cheese a good substitute.

MARY.

That is very pleasant; we can study practical crystallography after dinner. I will cut out some cubes, and truncate and acuminate their angles, and bevel the edges of them.

FRANCES.

I am very anxious to know how you find out by what decrement one crystal is derived from another; for, since the faces of natural crystals are smooth, you cannot see the laminæ.

MRS. L.

I am sorry, Frances, that I cannot satisfy your curiosity. Before you can understand the answer to that question, you must know a great deal more of mathematics than you do at present. I can tell you, however, something relating to it. If we wish to ascertain any particular decrement, (suppose that which produces the metastatic dodecahedron of carbonate of lime,) we must measure the angles of the primitive and secondary crystal—I mean the angles of incidence formed by the meeting of two adjoining planes. In the rhomb we have two angles to measure; that formed by the planes A B C D and A D E F, and the angle formed by the meeting of the upper and lower planes in the edge C D or D E, as well as the angle formed by the planes *a b c* and *b c s* of the dodecahedron (fig. 10.).

MARY.

And how is that done?

MRS. L.

By means of an instrument called a goniometer. But I must defer explaining to you the manner of using it till the next time we meet; for it is much later, I believe, than you imagine.

CONVERSATION V.

MRS. L.

I THINK you will be pleased with the subject of our conversation this morning—the Goniometer. Its function is expressed by its name, which is derived from two Greek words, gōnia (an angle) and mĕtreo (I measure). The reflective goniometer, which is the invention of Dr. Wollaston, is of infinitely greater utility than the one formerly in use, on account of the extreme accuracy with which the measurement of the smallest fragments may be determined.

FRANCES.

I suppose then that this is always used in preference to the original one?

MRS. L.

The common goniometer is of course less used than formerly; but there are some cases to which the reflective goniometer is not applicable; as when you wish to measure the angles of a crystal without detaching it from the accompanying substance. The common goniometer (fig. 23.) consists of a brass or silver semicircle, graduated into a hundred and eighty degrees, which are marked by short lines, extending from the rim to the concentric line within it; and two steel arms AB, FG. One of these is grooved or slit from *u* to *r*, except at *k*, where there is a little cross-piece to give more solidity to it. By means of this slit, and the two pins *m* and *n*, you may slide the arm in the direction of the diameter of the semicircle, which passes through the points 0° and 180°. The pin *m* passes through a small piece of brass behind the arm F G, which is attached to the semicircle at N, and by the bar O.

MARY.

Why does not the slit in the other arm extend both ways from the centre?

MRS. L.

Because it is necessary, that when the edge *z s* cuts the semicircle in any of the lines indicating the degrees, it should be in a line with the centre. As the arms are now fixed, a line would pass through the mark at 90°, and the centre, and along the edge *z s*; but it turns on the pin *m*, so that you can move it round to any other part of the circumference; and you can also shorten the distance from C to B by sliding the arm upwards. Now, if we wish to measure the angle of inclination of any two planes, we must measure the angle formed by two right lines perpendicular to the edge, which is their common section.

FRANCES.

I see that; the angle formed by the two planes (fig. 3.) ADEF and ADCB, is the angle included by the lines perpendicular to the edge AD.

MRS. L.

Place the goniometer, then, so that the edges of the two arms shall touch these two planes, and be perpendicular to the line of intersection; hold it between your eye and the window, and you will see whether the instrument is in perfect contact with the planes.

FRANCES.

I think it touches exactly now: I cannot see any light between the goniometer and the crystal.

MRS. L.

Now look at the semicircle, and you will see the number of degrees of the angle, indicated by the edge *z s*.

FRANCES.

It is 105 degrees.

MRS. L.

That is very nearly correct: we can scarcely measure with greater exactness by means of this instrument. If the crystal had been imbedded in some foreign substance, it would have been necessary to shorten the distances C B and C F, and to remove a part of the semicircle: there is a hinge at the mark 90°, and another where the bar *o* is fixed behind the pin *m*, by means of which the part D M can be placed exactly behind M N: if you have measured an obtuse angle, it will be necessary to replace the part D M to find the number of degrees. Let us now look at the reflective goniométer, which measures the smallest part of a degree with great nicety.

MARY.

It appears to be a much more complex instrument than the other.

MRS. L.

At first: but the principle on which it is constructed is very simple. A B (fig. 24.) is a graduated circle, of which *c* is the axis: one end passes through the upper part of the two brass supports *p p*. To the other end of this axis the circle *d* is attached as a handle, by which the large circle is turned: by moving this, we also move the axis *e*, which is inclosed in the other, and, passing through the centre of the great circle, is attached to the apparatus *i*, *h*, &c.

FRANCES.

Can this apparatus be moved without the assistance of the handle *d*?

MRS. L.

Yes; it can he turned by moving the circle *f*, which is fixed to its axis *e*; and this motion does not at all disturb the position of the great circle. The crystal of which the angles are to be measured must be attached to the cylindrical stem *o*.

MARY.

How can I stick it on?

MRS. L.

With a little wax:—thus. It should be so placed that when the stem is vertical, one of the faces forming the angle you wish to measure shall be horizontal, and the edge as nearly as possible in a line with the axis of the circle A B.

As the use of this instrument depends on the reflection of light from the planes whose inclination we are to ascertain, I have chosen a fragment of sulphate of barytes, because the cleavage surfaces are very perfect and brilliant.

MARY.

Shall I not measure the angle of a primitive crystal?

MRS. L.

Recollect that the planes of cleavage are parallel to those of the primitive form; and they are usually not only more brilliant, but have not those little inequalities, from which the natural faces are so seldom free.

If you hold one of these small fragments below and very near to your eye, you will see on it the reflection of the window-bars.

MARY.

I see them very distinctly:—look, Frances.

FRANCES.

O, yes; and the chimneys of the opposite houses.

MRS. L.

You will see them also in the piece which I have attached to the goniometer; and observe whether the reflection of the bars is horizontal. Having fixed the large circle so, that 180° on the graduated edge may coincide with 0° on the vernier, turn the crystal by means of the handle *f*, till the reflected bar appears on the black line *v* drawn on the wainscot between the window and the floor. If that movement alone will not do, you must raise or depress the crystal by pushing the stem through the tube *n*.

MARY.

I have brought the reflection to the black line, but it is not horizontal;—what must I do?

MRS. L.

You can correct that by drawing the circle *m* to the right or left, so as to move the curved piece of brass *i*, on the pin at *r*, while you continue to look at the reflection.

MARY.

Now it is quite right.

MRS. L.

You must next turn the crystal *from* you, together with its support and the graduated circle, until you see the reflection of the *same bar* in the adjoining plane. Therefore turn the circle *d*, keeping your eye fixed; and stop when the reflection again meets the black line.

MARY.

I hope I have not made any mistake: the new reflection makes a great angle with *v*.

MRS. L.

That is of no consequence. You must rectify it by turning the stem *o*, circularly, in the tube *n*.

MARY.

Will not this motion disturb the position of the first face?

MRS. L.

No: for though it is *moved*, it is still *in the same plane*; consequently the reflection on it will still be horizontal.

MARY.

Now I will just go through this part of the operation again, because I could not keep my eye fixed—There is the second reflection.

MRS. L.

And the graduated circle indicates 101° 20′ for the angle of the prism; which is near the truth.

MARY.

And what ought it to have been?

MRS. L.

101° 42′: but it requires practice to use this instrument expertly; for you will be likely at first to forget what movements you should make, and thus derange what you have done.

Now, I wish you would endeavour to explain why the reflection of a fixed object from the two planes, gives the angle of their inclination with such precision.

MARY.

I am afraid, Mrs. L., that such an attempt would detain you all the morning; and, as Frances has not used the instrument, I am sure she would not understand my bad explanation.

MRS. L.

I will show you, then. Let *a b c* (PLATE II. fig. 25.) represent a prism, or fragment, of sulphate of barytes; and *a b*, *b c*, imaginary lines, perpendicular to the line of intersection: looking on the plane *a b*, you see the image *q* of the chimney *p*, inverted on the black line; then, if you turn the crystal till you see the reflection in the plane *b c*, it must move through the space *g d*, which is the supplement of the angle *a b c*, because the line *f g* must come to the position of *e d*.

MARY.

That is very evident: but if it only moves through the angle *d b g*, which is acute, what is the reason that the index points to 104° 42′?

MRS. L.

Because the circle is graduated from 0° to 180°, from *d* towards *f* and *e*, and from 0° towards *g* and *d*.

FRANCES.

I like this instrument very much; it is so accurate, and the construction of it is so simple.

MRS. L.

It is a valuable addition to the apparatus of a mineralogist, for which we are indebted to Dr. Wollaston *.

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* A goniometer has lately been invented by M. Adelmann, which is described and highly recommended to the use of mineralogists by Count Bournon. The principle however being the same as that of Carangeot's (described at p. 68), it does not appear to be capable of measuring with the same ac-

Minerals which do not crystallize occur in various external forms, some of which are very characteristic of particular species, such as the botryoidal form of calcedony and malachite.

FRANCES.

What is the meaning of botryoidal?

MRS. L.

Having the form of a bunch of grapes. Some present a dentiform or tooth-like appearance; and others are arborescent or dendritic, that is, appearing like the branches of trees, or moss: but I can explain all these forms much better when I show you the substances in which they occur.

Transparency is a property not possessed by all minerals: some are semitransparent; as carnelian and some kinds of obsidian; others are only translucent.

MARY.

Does that mean nearly opake?

MRS. L.

Yes, it does: a few minerals become more transparent by immersion in water; which is the case with a kind of opal, called hydrophane.

It is of the greatest consequence to observe the fresh fracture of a mineral; that is, the appearance of a fresh broken part; because it is perfectly clean, and you can better observe the form and lustre which are peculiar to it, than in a part which has

curacy as the reflective goniometer: I have therefore thought it unnecessary to describe it.

been exposed to the weather, or otherwise injured by external causes: but observe, that when I speak of the different kinds of *fracture*, I do not include under that term *cleavage*, which is peculiar to some crystallized minerals.

FRANCES.

Are not all minerals which crystallize capable of division by cleavage?

MRS. L.

In some crystallized minerals the cleavage is obtained with such difficulty, that were not the primitive form known, it might be doubted whether they possessed a cleavage: in such substances the fracture is generally conchoidal.

MARY.

What sort of fracture is that?

MRS. L.

The word conchoidal means literally, having the form of a shell; but as that expresses nothing precise, I should say that a conchoidal fracture very much resembles the form of a muscle shell. I mentioned that it is exceedingly difficult to obtain the cleavage of some minerals, as spinel ruby, zircon, and quartz: on the contrary, there are substances which divide so readily, parallel to the primitive form, that it is difficult in *them* to produce any other fracture; such are sulphate of barytes, diamond, and carbonate and fluate of lime: a specimen of any of these having a conchoidal fracture is valuable to a collector.

You must not expect always to find a *perfectly* conchoidal fracture; it is very often confused and irregular. The form of the fracture varies with the texture of the mineral: in those which are compact, it is even, conchoidal, splintery, uneven, earthy, or hackly. The last kind is peculiar to the native metals; and you may see it by breaking a piece of silver or copper wire. Common chalk and fuller's earth are good and familar examples of earthy fracture.

FRANCES.

What do you mean by an *uneven* fracture; because I should have thought the two kinds you have just mentioned were uneven?

MRS. L.

They are so: but their appearance is better expressed by the terms hackly and earthy, and neither of these could with propriety be applied to the kind of fracture which we call uneven; the fracture of copper pyrites is generally uneven. The fibrous fracture, exhibited by some minerals, may be considered as the effect of their structure: this appearance is frequently produced by imperfect crystallization, as in some varieties of zeolite and sulphuret of antimony, where the terminations of the crystals are often plainly observable on the exterior of the mass; but this is not always the case, for amianth and asbestus always consist of a number of delicate silky fibres, without any appearance of crystallization. A multitude of small acicular crystals sometimes diverge from a point as a centre; and when the aggregate mass is broken, it presents a fracture which is called radiated. The most beautiful example of this kind, which I can recollect, is wavellite.

MARY.

I do not exactly know what is meant by an acicular crystal.

MRS. L.

Resembling a needle. All crystals which are pointed and very thin in proportion to their length are called acicular.

FRANCES.

I believe *lustre* is the next of the external characters:—Is it an important one?

MRS. L.

Yes. In some minerals, where the colour and form of the fracture are the same, the lustre is a distinctive character; as sometimes in bloodstone and green jasper. The principal kinds of lustre are the adamantine, the vitreous, the oily, the resinous, and the pearly; the metallic lustre which is peculiar to some of the metallic ores, and is always accompanied by opacity; and the semi-metallic which characterizes several earthy as well as metalliferous minerals.

MARY.

Is the adamantine lustre peculiar to the diamond?

MRS. L.

Not exclusively. White carbonate of lead possesses this kind of brilliancy.

I need scarcely explain to you the meaning of the other terms, as their relation to well known substances is obvious. The fracture of quartz is generally vitreous; the zircons and hyacinths of Ceylon have a remarkably oily lustre; the lustre of pitchstone and semi-opal is resinous; and sulphate of lime (selenite) has, in general, a beautifully pearly appearance.

FRANCES.

I do not think I should ever confound these different kinds—they appear to be very distinct.

MRS. L.

You will soon have an opportunity of exercising your discernment: but you will not always find it easy to know to which kind you should refer the character of a specimen. You will find some in which the lustre is intermediate between two kinds; as quartz, in which the vitreous lustre often approaches to oily. We must also observe the *degree*, as well as the *kind* of lustre—thus, the highest degree of brilliancy is called splendent; and we descend through the various degrees shining, glistening, and glimmering, till we arrive at that which is called *dull*, and is to be observed in most of those minerals of which the fracture is earthy. Each of these, like the other characters of the fracture, may be so qualified as to express intermediate degrees. We say the lustre is strongly, or faintly, glimmering; passing into glistening: but these nice distinctions are not often necessary, unless in describing a newly discovered substance.

MARY.

I should imagine hardness to be a useful character in discovering the nature of a mineral, because it can so easily be tried.

MRS. L.

You are right. Hardness is a very unvarying property in most simple minerals. It is remarkable, however, that, in crystallized substances, the edges and solid angles of the crystals *appear* to be harder than their faces.

FRANCES.

That is very singular—how do you account for it?

MRS. L.

There are two reasons for this apparent difference: first, an angular point will scratch a mineral much more readily than a flat surface can;—and, secondly, it is more difficult in crystalline minerals to produce a fracture by breaking off a point, than to split it in the direction of the cleavage. It is for this reason that the diamond-cutters distinguish the angles of a dodecahedral crystal into *hard* and *soft* points;—those which are also the angles of the primitive octahedron they call hard points, because they cannot split or break them off, and are obliged to rub them down with diamond powder; but they remove by cleavage the low triangular pyramids which form the other points.

MARY.

Then, if I want to try the hardness of a minera whose name I do not know, I must try whether it will scratch, and whether it can be scratched by one which I *do* know.

MRS. L.

Certainly; but I advise you not to make a point of scratching all minerals with which you are unacquainted; for you may meet with some which, though hard, are brittle, and by too much pressure you will inevitably destroy them; therefore you must be careful not to mistake hardness for tenacity, or frangibility for softness.

FRANCES.

Frangibility is the degree of ease with which a mineral may be broken, I believe?

MRS. L.

Yes, it is. Some hard substances are very frangible or brittle, as euclase and anthophyllite; others, which are very soft, are extremely tough or tenacious: of this I cannot give you a better example than asbestus, or amianth. These two minerals are also flexible.

MARY.

Is there any difference in the meaning of flexible and elastic?

MRS. L.

Yes, a good deal. Every thing is flexible that is capable of being bent without breaking; but a mineral which, after it is bent, springs back to its original form, is elastic. Mica is elastic; but talc, which very much resembles it, is only flexible. The minerals which possess the property of adhesiveness are very few.

FRANCES.

I do not understand how a mineral can be adhesive.

MRS. L.

They adhere to the tongue when applied to it: adhesive slate derives its name from this circumstance. You may observe the same thing in most species of clay, though not in so high a degree. The nature of specific gravity I have already explained to you, and the utility of determining it. *Taste* is confined to the saline minerals, which are soluble in water; such as muriate of soda (or rock salt) and alum: it is a property possessed by comparatively few substances. Those which emit any odour are, perhaps, not more numerous. Some minerals have a particularly disagreeable smell when rubbed. On rubbing together two pieces of quartz, you will perceive a faintly sulphureous odour.

MARY.

I recollect rubbing together some white pebbles once in the dark, to see the light which was produced, and they smelt like sulphur.

MRS. L.

They were quartz pebbles, and the light which you saw was phosphorescent.

MARY.

Do they contain phosphorus?

MRS. L.

No; but that kind of light is so called from its resemblance to the light emitted by phosphorus *. Some minerals become phosphorescent when heated, which is the case with most species of fluor, and a few kinds of carbonate of lime. Electricity is a character with which you are already acquainted.

FRANCES.

Yes, I remember you have told me that amber was electric—when it is rubbed it attracts small pieces of thin paper and bits of cotton.

MRS. L.

A great many substances are electric when rubbed, but in a *few* this property is excited by heating them. You recollect, perhaps, that there are two kinds of electricity, the one called positive, and the other negative; the one produced by the friction of glass, the other by rubbing any resinous substance, such as a stick of sealing-wax, which, on account of its form, is convenient for making an experiment. When this property is excited in a mineral, by *heating* it, it acquires electric poles; that is, positive electricity will appear on one part, and negative electricity on the part which is opposite.

MARY.

That is a very curious property;—how is it determined?

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* Emitted by combustion at the common temperature of the air.

MRS. L.

By means of a little instrument, called an electrometer, which you shall see. (PLATE III. fig. 26.) It consists of a glass stem *a*, which is fixed in a small wooden base *b*, and to the end *c* a very small piece of gold paper *d* is attached by means of a silk thread. You must hold the mineral in a pair of pincers *e*, of which the handle is glass, and warm it over a candle.

FRANCES.

Why is the handle of the pincers made of glass?

MRS. L.

Because glass is a non-conductor of electricity; that is, electricity will not pass through it. Here is a crystal of tourmaline, a substance in which electricity is very easily excited. If, when it is warm, you present one end of it to the gold paper, it will attract it.

MARY.

Yes, I see it lifts it up.

MRS. L.

But if you shake it off, and again present the same end, it will repel the paper.

MARY.

So it does—the paper flies to the distance of an inch from it.

MRS. L.

Now the other end will attract it.

FRANCES.

I believe I know the reason of that—is it not because the electricity is of a different kind in the two ends of the tourmaline?

MRS. L.

Yes; two substances, possessing the same kind of electricity, mutually repel each other, as you saw when you presented to the gold paper the end with which you had charged it; but the other end, having a different kind, immediately attracted it.

MARY.

But how do you find out which end is positively or negatively electrified?

MRS. L.

By charging the gold paper with either kind, and then trying which end of the tourmaline will attract it.

FRANCES.

I should like to find that out.

MRS. L.

Very well—Rub the stick of sealing-wax to excite it, and touch the gold paper with it. You will find the green baize table-cloth a better substance to rub it on than your sleeve, because the friction will be greater.

FRANCES.

This is the positive end, Mrs L.; it attracts the paper.

MRS. L.

Charge the paper again, and try the other end.

FRANCES.

How is this? are both ends become positively electric?

MRS. L.

No; but, in substances in which electricity is produced by exposure to heat, the poles change places during the time of cooling.

MARY.

But is that always the case?

MRS. L.

I believe it is. There are so few minerals in which electricity can be excited by heat, that it is a curious, rather than a useful, character. But I must observe to you a very singular circumstance attending those which do possess it. In most substances crystallization takes place with perfect symmetry; whatever decrement produces a plane on one angle of the primitive form, will also produce one on every similar angle; and in the cube and octahedron, where all the angles and all the edges are similar, they are all similarly affected, (as in Plate I. figs. 12 and 13.) but in the minerals which become electric by heating, the two points where the different kinds of electricity reside, are differently crystallized. If you examine the tourmaline, on which you have been experimenting, you will see that the two terminations are different.

FRANCES.

Yes; there are six planes at one end, and only three at the other. (Plate IV. fig. 65.)

MRS. L.

Borate of magnesia is a still more curious example of this formation; for, though the primitive form is a cube, only four alternate angles are modified. (fig. 237.)

MARY.

But is there not a kind of regularity in the crystals of this substance, with regard to the position of the modified angles?

MRS. L.

Yes. You will find that, of the four angles which belong to each square surface, two are modified, and two are not; those which are unaltered being placed at equal distances from each other, and alternating with those which are modified. You must be careful in making this experiment not to smoke the mineral by holding it over the candle; because, if it be a substance in which electricity is not produced by heat, you may excite it by the friction occasioned in wiping it. You must also take care not to make it too warm.

FRANCES.

Would that lessen the degree of electricity?

MRS. L.

Above a certain degree of heat, the electric property gradually decreases, till it disappears entirely; and, if you still continue to augment the temperature, the poles will be changed as in cooling.

MARY.

I am sorry that electricity is not more useful, what you have told me appears so curious. Is magnetism a useful character?

MRS. L.

Not very often; but it is a property easily examined by means of a polar magnet.

FRANCES.

Is that different from a common magnet?

MRS. L.

Yes; the polar magnet is a small bar of magnetic steel, *a* (PLATE III. fig. 27.) which is supported on a pin, so as to turn with the greatest ease; and, when left at rest, it always points towards the north.

MARY.

This, then, is the magnet used in ships?

MRS. L.

It is exactly the same kind of thing. The two ends of the bar are called the north and south poles; and, in this respect, magnetism resembles electricity; for the north poles of two magnets will repel each other, and so will the two south poles; but the south and north poles will mutually attract each other. Many substances will attract either end of the magnet to which they are presented,—such as magnetic pyrites, and those minerals which contain a large portion of iron; but some ores of iron possess polarity, that is, the power of attracting one, and repelling the other of the poles.

FRANCES.

I had no idea that iron existed in so large a quantity as to attract a magnet except in iron ores.

MRS. L.

Wedgewood's black ware, which is made of basalt, attracts it very strongly; but the quantity of iron contained in some minerals is so small, that it is necessary to place the magnet differently, in order that it may move still more readily. This is done by making the north pole (A) of the bar (fig. 28.) point either to the east or west, by means of the attraction of a stronger magnet (B): you must move this magnet (B) till you find that the attraction is just sufficient to keep the polar one in the position required. Now, if any substance containing iron be brought near it, you will find it an extremely delicate test.

MARY.

What can I try?

MRS. L.

I dare say this fragment of actinolite will have some effect on it, though, perhaps, it would not in the usual way of making the experiment.

MARY.

Yes, it moves it a little; but very slowly.

MRS. L.

But you see that, as the magnet returns to its natural position, it moves rather more quickly. The reason of this is obvious. The magnet has a constant tendency to point to the north and south, and a substance containing so small a portion of iron would not have sufficient attraction to overcome that tendency; but, when the attraction of the pole and the magnet B are very nearly equal, the slightest attraction, in addition to that of the pole, will cause it to return to its former situation*.

MARY.

Yes, I see that clearly.

MRS. L.

Now, if you like, I will show you how to use the blowpipe.

FRANCES.

That is a chemical instrument, is it not?

MRS. L.

Yes; and it is very useful to a mineralogist.

FRANCES.

Do you analyse minerals with it?

MRS. L.

That is not always the object in using the blowpipe, though many substances may be partially decomposed by it. It is a tube of metal, used to direct and concentrate the flame of a candle or lamp, so

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* This is a rather tedious experiment, and requires care and patience to perform it successfully.

as to produce a great degree of heat, which has very different effects on different substances when exposed to it. This heat is produced by forcing a continued stream of air through the tube against the flame.

MARY.

But would not the air extinguish the light?

MRS. L.

Not when the air passes through a very small aperture, as in the blowpipe. A great many blowpipes have been invented which supply the flame with a stream of atmospheric air, with oxygen, or an inflammable gas, such as the vapour of boiling alcohol; but all these have their disadvantages for a mineralogist. The greatest heat is produced by the action of Dr. Clarke's blowpipe, which supplies the flame with a current of oxygen and hydrogen, previously condensed*: it is so intense, that it melts all substances.

Oxygen also produces intense heat; but as the minerals when exposed to these melt almost immediately, you cannot see any of the previous changes which take place in a lower degree of heat, and which should always be observed. Inflammable vapour produces a large flame, but wavering and unsteady, which is not sufficiently intense for

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* For a particular description of this instrument (which is more valuable to the chemist than to the mineralogist) the reader is referred to a pamphlet written on the subject by Dr. Clarke, of Cambridge.

most purposes: and pure atmospheric air, as well as these, must be furnished by some mechanical contrivance, which is always more or less cumbrous, and not portable, as the apparatus of a mineralogist ought to be.

FRANCES.

Then what kind of air is generally used?

MRS. L.

It is found that air which has been *once* breathed produces very nearly the same effect as atmospheric air; therefore, with a portable blowpipe, the stream may be supplied from the mouth; a circumstance which greatly contributes to the utility of this instrument.

MARY.

Is it easy to use?

MRS. L.

It requires some practice to be able to produce a constant and equal stream of air. You should acquire the habit, not only of breathing through your nostrils easily, so that the current of air may not be interrupted by taking breath, but of doing so when your mouth and cheeks are inflated by air. When you can do this, you will find little difficulty in using the blowpipe, provided you do not attempt to work too hard.

FRANCES.

Are both these blowpipes (figs. 29 and 30.) to be supplied in this manner with air?

MRS. L.

Yes: the principal difference between them is the addition of this hollow cylinder *c* (fig. 29.), for collecting and retaining the moisture of the breath, which is here condensed. The other, called Dr. Wollaston's blowpipe, has not this cavity, but it is still more portable, being made in three pieces, which when fitted thus (fig. 30.) are air-tight; but by putting this tube *b* (fig. 31.) within the other, and using the nozzle as a stopper, it may be packed in a very small compass, and is convenient for travelling. If you will light that candle, you shall see the manner of conducting an experiment.

MARY.

Would not a lamp be better?

MRS. L.

No; a wax candle with a wick not too thin is found to be, upon the whole, the best adapted to this purpose. Before I begin, I bend the wick a *very little* from the blast of the pipe.

FRANCES.

How steady and clear the flame is!

MRS. L.

Observe that the flame, when thus acted on, consists of two conical parts, the one contained in the other: the outer one is of a yellowish white colour, the other pale blue; and the greatest heat is just at the point of the blue flame.

MARY.

But on what do you support the mineral which is to be exposed to the flame?

MRS. L.

There are several substances which may be used as supports, according to the nature of the mineral to be experimented on. Charcoal is chiefly used for the reduction of metallic ores; and it should be a sound, close-grained piece; otherwise, in the middle of an experiment, the melted globule may disappear in a rift or crack.

FRANCES.

But would not some other more solid and incombustible substance, answer better?

MRS. L.

Not in all cases. It is easy to make a little hollow in the charcoal, in which the ore may be conveniently placed; but for examining earthy minerals we generally make use of small strips of leaf platina.

MARY.

Why is that the best metal for the purpose?

MRS. L.

Because it is the most infusible of all the metals, and transmits heat to a less distance than any other. So that you may, without inconvenience hold one end between your finger and thumb, while the other is exposed to the action of the blowpipe. Platina forceps will be found useful for holding small fragments, but when fluxes are to be used, leaf platina must be resorted to.

FRANCES.

Pray, what are fluxes?

MRS. L.

They are used principally with the metallic minerals, for the purpose of dissolving the earthy matter with which the oxydes are combined; and they furnish a glassy substance nearly colourless, but to which colour will be communicated by the oxydated metal. As an example, I will mix with this flux, which is borax, a small piece of the ore of cobalt.

MARY.

Will that quantity be sufficient?

MRS. L.

I am only afraid that I have too much; for the colour of the metallic oxydes is so intense, that in general a piece the size of a very small pin's head is quite enough: if the quantity be too great, the result will be a glass apparently black.

MARY.

I see you do not at first expose it to the hottest part of the flame.

FRANCES.

How the borax boils and crackles!

MRS. L.

It would have been better to use glass of borax as it is called, which is borax deprived, by heat, of the water it generally contains, and has the appearance of glass.

MARY.

Now there is a white smoke rising from it.

MRS. L.

That is occasioned by the arsenic it contains; the smell of this vapour is very characteristic of arsenic.

FRANCES.

It is very disagreeable.

MARY.

It smells exactly like garlic.

MRS. L.

Now my experiment is finished.

MARY.

The cobalt has tinged the glass with a beautiful blue.

MRS. L.

By this simple operation you may always detect the presence of cobalt and arsenic, and of many other substances; but it is not necessary at present to explain to you the effect produced by the blowpipe on several other metals which may be discovered in the same manner.

FRANCES.

This is a delightful experiment, it is so simple and easily managed; and the result is so satisfactory.

MRS. L.

I would advise you, if you travel, to get a little apparatus, called a mineralogical pocket-book; it contains an electrometer, a polar magnet, a blowpipe, a pair of forceps, leaf platina, and small bottles filled with fluxes and acids.*

MARY.

What is the use of the acids?

MRS. L.

Many substances may be known by the effect of acids on them; some, when reduced to powder and mixed with an acid, in the course of a few hours become a perfect jelly. The native carbonates, when touched with an acid, effervesce; some more vigorously than others.

FRANCES.

Is any mineral then, that will effervesce with an acid, a carbonate?

MRS. L.

Yes; but you must remember that when there is some foreign matter combined with the carbonate, the effervescence will be but slow: you will sometimes find it necessary to use a magnifying-glass, and occasionally, a little water is to be

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* They are fitted up, and sold by Mr. Cary, optician, Strand.

added;—the acid may be too strong to produce the proper effect. If you still suspect that a disengagement of carbonic acid ought to take place, you may pulverize a little before you add the acid.

MARY.

But I do not understand why a mineral should effervesce because it is a carbonate.

MRS. L.

Effervescence is the disengagement of the carbonic acid, which when free is in the state of gas.

FRANCES.

Is it not liquid, then?

MRS. L.

No; it is an aëriform acid, heavier than common air or oxygen. In making a saline draught, you disengage the carbonic acid from the carbonate of potash or soda, by the addition of lemon juice, which contains citric acid; and it escapes in the form of bubbles;—the same thing takes place whenever a strong acid is brought in contact with a carbonate.—Now I believe I have shown you as much of chemical mineralogy as you will in general find useful in distinguishing one substance from another: the particular effects of the acids, alkalis and the blowpipe on many other minerals I shall be able to show you when you see them.

CONVERSATION VI.

MARY.

What beautiful specimens! If all minerals were as brilliant as these, how delighted I should be.

MRS. L.

If it is only the brilliancy of them which pleases you, I am afraid you will be very much disappointed when you see a drawer full of coal or clay; but, when you know more of the subject, you will find many specimens very interesting, which *now* you would, perhaps, scarcely think worth looking at.

FRANCES.

Are these amethysts, Mrs. L.?—I should suppose they were, from their colour.

MRS. L.

They *are* amethysts; but not merely because they are purple; for this specimen is amethyst, though quite colourless. The name* was, at first, given to the purple variety of this mineral by the antient Greeks (to whom it was known at a very early period), on account of the power they

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* From *α not,* and *μεθυστος* (methystos) *drunk.* See Appendix No. I. at the end of vol. 2.

imagined it to possess of preventing intoxication: and, for this reason, they often wore a ring or some other ornament made of amethyst, as an amulet, that they might drink freely without fear.

FRANCES.

What a strange idea! How do you think it could have arisen?

MRS. L.

It is said to have originated from the similarity of colour in wine and the amethyst (for none were called so formerly but such as were purple); and it is not more absurd than the prejudice which has induced people (even in England) to prescribe black or yellow medicine, for the black or yellow jaundice; being thought more efficacious than medicine of any other colour*.

MARY.

I cannot imagine how any one could believe such ridiculous notions, or how they could persuade others to believe them.

MRS. L.

And yet the fabled property of the amethyst was so universally believed, that we find it frequently alluded to in the works of the antients. This brings to my recollection a description of an amethyst ring,

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* In the year 1644, Sir Kenelm Digby published a work "On the Nature of Bodies," in which he treats at great length of sympathies.

which I read, not long ago, in a beautiful romance translated from the Greek.

MARY.

Can you remember it, Mrs. L.? I should like to hear it.

MRS. L.

I thought the passage curious, and transcribed it: I will read it to you. "The ring was a miracle both for materials and workmanship. The circle was amber; the stone of an Æthiopian amethyst, of the size of a virgin's eye; finer much than those of Spain or Britain; for these have a quick tinge of purple, without glittering, like a rose just bursting from the bud, and ready to expand its blushing leaves to the sunbeam: but the Æthiopian amethyst shines with a deeper and more sparkling lustre; on the least motion it throws its beams on all sides, yet does not injure, but delight and cherish the sight. They are besides, of much greater virtue than the Western ones; they do not belie their name, but will really keep those who wear them sober amid great excesses. This property is common to all Indian and Æthiopian stones; but that which Calasiris gave to Nausicles was of still more inestimable value, for it was carved with wonderful art.

"The sculptor had represented a shepherd feeding his flock. He sat upon a rock, moderately raised from the ground, surveyed his sheep, and distributed them into different pastures by the various notes of his pipe. They seemed to obey, and to feed as the sound directed them. You would say that they had golden fleeces; the natural blush of the amethyst was so contrived to glow upon their backs. Here you might observe the frolics of the young lambs; some climbing up the ascent, others playing around the shepherd, made the picture a truly pastoral spectacle. Some, basking in the flame of the gem, like the sun, wantoned at the foot of the rock; others, older and more bold, seemed as if they would overleap the circle; but here art had hindered them, and surrounded the circle with a golden inclosure. The rock was not an imitation, but real; the artist, to represent that, had seized on the farther part of the stone, and was not put to the trouble of feigning one by the illusions of his art."*

MARY.

Thank you. That is a very minute description.

FRANCES.

Before you proceed any further, will you have the goodness to tell me why you place amethyst at the beginning of your arrangement, in preference to any other precious stone?

MRS. L.

I am glad to find that you like to have a reason for every thing. It is not because amethyst is a *precious stone* that it takes precedence of other

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* "Theagenes and Chariclea," by Heliodorus.

substances; but because it is a kind of *quartz* or rock crystal, which, for several reasons, seems entitled to the first place in the system, as I shall endeavour to show you.

Every system of mineralogy must be founded either on the chemical or on the physical characters of minerals, or on a combination of both. The latter are the most convenient and useful, though not the most perfect, and, therefore, are most generally adopted; but there is a great diversity of opinion on an important question which naturally suggests itself, namely, where shall we begin? The French mineralogists, who have paid great attention to the crystallization* of minerals, considering it as the most important character, have, in general, placed at the beginning of their systems those minerals which are composed of an earth and an acid. The mineralogists of the German school appear to have selected a substance arbitrarily as the first in their arrangements, and to have formed their genera and families with much less regard to the chemical than to the physical characters; and even amongst *these*, have paid least attention to that which is certainly, where it exists, the most unvarying: I mean crystalline form. But I think we should try to discover whether there be not any kind of *natural*

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* It is to the Abbé Haüy that we are indebted for the explanatory theory of the structure of crystals.

order, which might, at least partially, be observed in the formation of a system.

MARY.

Certainly; if such an order really exist, one would wish to adopt it.

MRS. L.

We know that the great masses which constitute the crust of the globe are chiefly earths: these are by far more abundant than the metallic, alkaline, or inflammable substances; and are considered to be in general more antient. You are surprised, and it is natural that you should be so; but it is an opinion almost universally received, by geologists, that the different parts of the globe are not of contemporaneous origin.

FRANCES.

How is it possible to prove the truth of such a supposition? or why is it believed that the different parts of the world were not all formed at the same time?

MRS. L.

An attentive examination of the geological structure of various countries has led to this conclusion; and it is a proof of the intimate connexion of mineralogy with geology: for you see that neither can be properly understood without the assistance of the other.

When you know something of mineralogy, I shall speak a little of the other branch: but at present you must, if you please, take for granted what I have said on the subject, as you do the axioms of Euclid.

MARY.

Indeed, Mrs. L., I shall be very glad when you think me able to understand the proofs of your doctrine; and, in the mean time, I will endeavour not to be sceptical.

MRS. L.

I have little doubt that you will be satisfied with the arguments which are adduced in support of this theory. The knowledge of the different ages of minerals shows us that they may be arranged in a succession somewhat natural. The earthy minerals, being of more antient origin than the metallic ones, should precede them; and the inflammable * substances, which appear to be of comparatively recent formation, should consequently succede the metallic ones. The first class is divided into earthy and acidiferous earthy minerals.

FRANCES.

The term acidiferous, I suppose, is applied to those minerals of which some acid is a constituent.

MRS. L.

You are right: but observe, that the acidiferous

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* Inflammable and Combustible are not synonymous terms. All metals are combustible; that is, capable of uniting with oxygen; but they will not burn in atmospheric air, and are, therefore, not called inflammable.

minerals do not all form one class; for acids are found in combination with the earths, with the alkalis, and with the metals; and sometimes one acid is combined with an earth and an alkali.

MARY.

All the alkaline minerals, then, cannot be arranged together.

MRS. L.

Those of which an alkali is the principal constituent, are soluble in water, and form the saline class, which may very well be the third.

The inflammable minerals are sulphur, the bituminous, carbonaceous, and resinous substances. But these two classes are much less extensive than the two others.

FRANCES.

I should suppose the metallic class to be the most extensive of all, as the metals are so much more numerous than the earths or alkalis.

MRS. L.

I am not surprised that you should think so; but you will find that the metallic minerals do not occupy above half as much space in my cabinet as is filled by the earthy ones.

FRANCES.

That appears very strange. I cannot imagine why it should be so.

MRS. L.

Though the combinations of metals are very numerous, the different species present, in general, much less diversity of aspect than those which have an earthy basis. Each species has a more fixed character, and their chief variety is in their crystallization. For example, when you have once seen a specimen of sulphuret of lead, or red oxyde of copper, you could scarcely mistake it for any thing else; though their crystalline forms are very various. But this is not the case with *earthy* minerals: their colouring matter, though in most cases not an essential ingredient, is frequently variable; and the same species occurs in very different states of concretion.

There is another reason for the greater variety of appearance in earthy than in metallic minerals; the great repositories of all, are rocks and masses of stone composed of earths: very frequently they are found imbedded in rocks of a different nature and composition; and the character of many earthy minerals varies with the nature of the mass in which they are found.

MARY.

And is not this the case with metallic ones?

MRS. L.

Not often: very few of the metals are found mineralized by the earths, but are united with oxygen, sulphur, or an acid, or exist in the state of alloys; and these compounds are never chemically intermixed with the surrounding rock or bed.

FRANCES.

I think I understand that: an earthy mineral cannot be imbedded in a mass of rock without some mixture of the particles of both substances taking place.

MRS. L.

This is generally the case with those which do not crystallize; and those which do, are sometimes, though rarely, affected by the nature of their repository.

Each class of minerals is divided into *genera*, containing one or more *families*, and these are subdivided into species and varieties.

MARY.

But if you arrange the minerals in *genera*, I do not understand what you mean by *families*: I should have thought they were different names for the same thing.

MRS. L.

The word *genus* means, literally, a kind; and the first division of the earthy class would naturally be into the principal *kinds* of earthy substances. We, therefore, have the siliceous, the aluminous, and the calcareous genus, with some others of less importance. The siliceous genus comprehends all stones of which silica is the principal constituent. All those which are composed principally of alumina are arranged in the aluminous genus, and so on. But many of these are *almost pure* silica, and are very similar in many of their external as well as chemical characters; as their specific gravity, their hardness, and their texture: these are all considered as belonging to *one family*. Other families consist of minerals, of which silica forms rather more than one half, but where some other earth is an essential constituent, and which have some external characters in common with each other, as the felspar family. But you will understand this better when you have seen some minerals. For the present, I will just give you what is called a *tabular view* of my arrangement of the first class.

EARTHY CLASS.

ORDER I. Earthy Minerals.

1st GENUS. (*Siliceous.*)

FAMILIES. Flint—Garnet—Idocrase—Schorl—Epidote—Pitchstone—Zeolite—Lazulite—Felspar—Mica—Slate—Clay—Lithomarge—Hornblende—Augite.

2d GENUS. (*Magnesian.*)

FAMILIES. Magnesite—Talc—Chrysolite.

3d GENUS. (*Aluminous.*)

FAMILIES. Ruby—Nepheline—Topaz—Cyanite.

4th GENUS. (*Zircon.*)

FAMILY. Zircon.

5th GENUS. (*Glucine.*)

FAMILY. Emerald.

ORDER II. Acidiferous Earthy Minerals.

1st GENUS. (*Calcareous.*)

FAMILIES. Carbonates—Phosphates—Fluates—Sulphates—Silicates—Borosilicates—Arseniates—Tungstates.

2d GENUS. (*Aluminous.*)

FAMILIES. Sulphates—Phosphates—Fluates—Mellates.

3d GENUS. (*Magnesian.*)

FAMILIES. Carbonates—Sulphates—Borates.

4th GENUS. (*Barytic.*)

FAMILIES. Carbonates—Sulphates.

5th GENUS. (*Strontian.*)

FAMILIES. Carbonates—Sulphates.

FRANCES.

I see there is no particular family for the precious stones.

MRS. L.

The idea that all precious stones are composed of the same elements, which was adopted by the early mineralogists, has long been discarded: they are now arranged according to their composition, which, in many, is essentially different. Amethyst is merely a kind of quartz.

MARY.

But, Mrs. L., you said that all pure earths were white;—what is it that gives this such a beautiful purple tint?

MRS. L.

A very minute portion of the oxyde of iron and manganese. In some of the paler specimens, you may see little tufts of fibres (which are crystals of oxyde of iron and manganese), and just around them the colour is deeper than in the other parts.

MARY.

O, how beautiful! they are like little hair pencils.

FRANCES.

This shows very plainly that the colour is not *necessary* to amethyst:—but what are its essential characters?

MRS. L.

Amethyst, as well as all the other species of the quartz family, possesses a certain degree of hardness; you cannot scratch them with a knife, or with glass.

MARY.

It is very easy, then, to discover a real amethyst from a false one, by trying if it will scratch glass.

MRS. L.

A more certain method is to try if it will scratch quartz; for most of the compositions made in imitation of precious stones are sufficiently hard to scratch flint-glass, but are softer than quartz. The specific gravity of the different varieties of quartz is, in general, about 2·6; they are all infusible before the blowpipe, without the addition of some other substance, and are rather brittle. The distinctive character of amethyst is that peculiar coarse fibrous fracture, or imperfectly columnar structure, which is more conspicuous in this white specimen than in the others.

FRANCES.

But is not this fracture radiated?

MRS. L.

In this instance it is—but that is not always the case with amethyst.

MARY.

Do lend me a magnifying-glass, Mrs. L.; I think the outside of this piece is crystallized.

MRS. L.

Most minerals which have a fibrous or radiated structure consist of an aggregation of crystals: this arrangement is also called fasciculated. I do not think you will be able to make out the crystals of the specimen in your hand, because the ends are small and imperfect; but they are exactly similar to those of rock crystal, which are large and more convenient to study. (PLATE III. figs. 35, 36.)

FRANCES.

Is all this specimen amethyst, Mrs. L.? It appears to me as if the points of the crystals were covered by some other substance like agate.

MRS. L.

It is calcedony, one of the principal components of most agates. It is not uncommon to meet with fibrous and crystallized amethyst in the centre of agate balls; but, in these cases, the points of the crystals are not imbedded in the agate, but appear to be growing on it, so that only the pyramids are seen lining the cavity. That crystallized specimen which you have just taken up was brought from Siberia—and those fragments are from the Brazils.

FRANCES.

These fragments puzzle me a little, for I see no marks of a fibrous structure.

MRS. L.

No, the fracture is conchoidal; and so it is in the crystallized part of *all* amethysts—but the fibrous varieties split so readily into columnar fragments, that you do not, at first, perceive the cross-fracture, as it is called.*

MARY.

I see it plainly, now you mention it.

MRS. L.

It is probable that these Brazilian amethysts are fragments of some large mass, partly fibrous, partly crystallized.—What would you say of the lustre of the fracture?

MARY.

I should think the lustre was vitreous; but I do not know what degree of brilliancy it has.

---

* The fracture of amethyst may be said to be fibrous in the large; conchoidal, in the small.

MRS. L.

The most brilliant varieties may be termed shining; the least so, glistening: but the *external lustre* varies from splendent to nearly dull.

FRANCES.

I think this is *quite* dull. How strangely the crystals are aggregated!

MRS. L.

Yes, that is not a common occurrence: when the large crystals appear so surrounded by smaller ones closely attached to them, the groups are said to be bud-shaped. This specimen is from Hungary—those of which the summits of the crystals are white, and the bases coloured, are from Mexico. I believe there is nothing remarkable in the others: they occur of every shade intermediate between dark plum-blue and white: sometimes the points of the crystals are purple, and the other part of a greenish tint: some have a milky appearance; and many of those, in which the purple colour approaches to brown, are nearly opake.

MARY.

You have, indeed, a very fine series of colours.

FRANCES.

Do amethysts come from any other places than those you have mentioned?

MRS. L.

A great many: they are found in considerable quantity in various parts of Saxony and Bohemia—

in Sweden, Switzerland, France, and Spain; in Iceland and the Faroe Isles; and I have a specimen from Mayo in Ireland. But most of those which are used by jewellers are brought from Cambay in India, Brazil, and Siberia—They are also found in Persia. The largest specimen of amethyst I ever heard of is a Brazilian one in the collection of the Royal Institution. It weighs 130 pounds, and the crystals vary from one to four or five inches in length.

MARY.

I recollect having heard of it; but I believe it was not of a good colour.

MRS. L.

No, it could not have been used for jewellery.

FRANCES.

And in what sort of rock is amethyst found?

MRS. L.

Chiefly in the veins of mountains with metallic ores; or with agate, in the cavities of greenstone and porphyry rocks. All the amethyst and quartz of Bristol is accompanied by ironstone; and there is some specular iron on the specimen from Cornwall.

MARY.

Well, I hope when I go into Cornwall that I shall find some; I assure you I shall not return without seeing the subterranean wonders of the county.

MRS. L.

It is not *impossible* that you may meet with them; but I fear you will be disappointed, for they are not plentiful there. You may get fine specimens of common quartz, and some of rock crystal.

FRANCES.

Are these rock crystals from Cornwall?

MRS. L.

No, I do not think that crystals of that size have ever been found in Great Britain; that specimen is from Madagascar, but most of the others from Dauphiné. The group of rock crystal on the cabinet, of which the crystals are nearly a foot in length, is from Madagascar; and there are some much larger in the British Museum.

MARY.

How very transparent these are! and beautifully crystallized. Is this the primitive crystal? (fig. 36, PLATE III.)

MRS. L.

No, that is one of the most common forms of rock crystal, but not the most simple—the primitive is a slightly obtuse rhomb.* (fig. 32, PLATE III.)

FRANCES.

Pray show me some, for I do not see any here.

---

* The angles of incidence of the planes are 94° 15′ and 88° 45′.

MRS. L.

They are very small, but you may see them distinctly on this specimen.

FRANCES.

Yes, I do; they are brownish.

MARY.

But, Mrs. L., are these little things rock crystals?

MRS. L.

Rock crystal is merely a name used to designate the transparent prismatic crystals of quartz, such as those from Dauphiné or the yellow variety from Brazil—they are all quartz; but when the prism is very short, as in these (fig. 35.), or it is not transparent, the mineral is called common quartz. The primitive crystals are from Bristol; and these also (fig. 33.) where you see the lower angles are replaced by small planes, which, if extended so as to meet, would form a triangular dodecahedron.

FRANCES.

Would it be similar to any of the dodechahedrons of carbonate of lime?

MRS. L.

It is not like the metastatic, or any other produced by that kind of decrement; but there is a crystallization of carbonate of lime, which is very rare, that resembles it. The faces of the common dodecahedron of quartz are isosceles triangles, and the base of the pyramids is a regular hexagon, which you know is not the case with the dodecahedrons of carbonate of lime in general. Quartz very rarely assumes any dodecahedral form except this (fig. 34.); but I have seen *one* like the metastatic of carbonate of lime, and most probably produced by a similar decrement.* Here is a very perfect dodecahedron from Spain.

MARY.

And where did you find these little crystals?

MRS. L.

In Derbyshire, near Bakewell. I have some also from Scotland.

MARY.

I think when you were speaking of crystallization, you said that it was extremely difficult to find the cleavage of quartz; —how could the primitive be obtained from one of these crystals?

MRS. L.

I believe the best method is to heat the crystal gradually to rather a high degree, and then plunge it into cold water; if it does not split immediately, you will perceive a number of cracks within it, which are parallel to the plains of the rhombic nucleus.

FRANCES.

Then I suppose a blow with a hammer would divide it into rhombs?

---

* In the possession of Henry Heuland, esq.

MRS. L.

A hammer will *sometimes* answer the purpose, but you will find different kinds of pincers useful in cleaving crystals.—Sugar-nippers are good things, and the little pincers which are used for cutting wire.

FRANCES.

I do not think I shall ever be tempted to destroy crystals for the sake of discovering the cleavage.

MRS. L.

It is probable that it will not be necessary for you to do so—as the primitive form of most minerals is known. The primitive rhomb, and the dodecahedron of quartz, occur much less frequently than the prismatic crystals. (figs. 36, 37, 38.)

MARY.

I cannot understand this crystal, Mrs. L.; it has the same number of faces as the one you have just shown me, but it appears very irregular.

MRS. L.

That irregularity arises from the different size of the planes of the pyramid; three of them have been extended at the expense of the others (fig. 37.), and the specimens from Dauphiné are characterized by the great size of *one* face.

FRANCES.

Here is one of that kind—it appears at first sight as if there were no other plane on the summit.

MARY.

But you may see them very easily with a glass (fig. 38.); two of them are very narrow,—the one opposite to the large plane is rather wider in proportion to its length; and the two others are triangles.

FRANCES.

No, Mary, they are not *both* triangles; one of them is a trapezium.

MRS. L.

I am glad you can easily discover these little planes, because you will derive amusement as well as instruction from looking over my crystals. But as there is great variety, I shall, at present, point out to you only the most remarkable.—Here is one, where the part which you would at first think to be a prism, is part of a very acute pyramid. (fig. 40.)

MARY.

Really, if you had not shown it to me, I believe I should have overlooked it.

FRANCES.

Is not this one of the same kind? (fig. 41.)

MRS. L.

Yes; but in this crystal the long pyramid has *nine* sides,—for three alternate edges are truncated.

MARY.

Is that a rare crystal?

MRS. L.

Yes, rather so.—On this crystal you will see a modification which, if complete, would produce an equiaxe rhomb,—You know where to look for planes formed by such a decrement. (fig. 42.)

MARY.

Yes,—they are the very narrow planes on the upper edges of the rhomb.

MRS. L.

That is only the commencement of the decrement.

FRANCES.

Is not that a crystal of Cairngorm?

MRS. L.

That is a common name for the quartz of a yellow or brown colour, because they were first found at the mountain of Cairngorm in Aberdeenshire; but that specimen is from Switzerland. The brown ones are sometimes called smoky quartz. The specimens are arranged so as to form what is called a *suite of colours*; that is, to show the different tints of each colour, passing into others. I have placed after the white and colourless quartz those which are grey and greenish, then the yellowish white, the different shades of yellow, the light brown, and the dark brown varieties, which pass into red, of which there are several kinds.

MARY.

Is there no pink or crimson quartz, Mrs. L.?

MRS. L.

Quartz has been found of a beautiful pink; but it never crystallizes, and is considered as a distinct subspecies.—Crimson quartz has not yet been discovered.—Crimson and blue are the two colours which occur less frequently than any others, in the mineral kingdom.—Green and red, (I mean the kind of red you see here,) and grey of various shades, are the most common.—The darkest and brightest specimens resemble Venetian red: the colouring matter of both is oxyde of iron.

MARY.

All the yellow quartz is very transparent, and most of the brown crystals—even some that are dark; but there is scarcely any red that is not nearly opake.—What is the reason of this?

MRS. L.

Their opacity arises from the large quantity, and unequal diffusion of the colouring matter. There are little crystals of this red quartz, found near Compostella in Spain, which are called Hyacinths of Compostella. I have fixed some on little pedestals, for they are beautifully crystallized, though not above a quarter of an inch in length. You see they are quite opake, and both ends crystallized.

FRANCES.

Have you any quartz containing drops of water? I recollect some specimens of it in the Museum.

MRS. L.

Yes, here is a crystal which contains a large drop. It is not very transparent; but if you move it gently between your eye and the light, you may see it.

FRANCES.

But how oddly it moves.

MRS. L.

The water is contained in a space larger than itself, and it is a bubble of air which you see moving in the water.

MARY.

Is not the mossy-looking substance in this crystal, chlorite?

MRS. L.

Yes,—how did you know it?

MARY.

Because it is so much like a specimen of quartz inclosing chlorite at the Museum. Is chlorite always dark green like this?

MRS. L.

No, it is sometimes brown; and in this crystal white, and in parts, of a light grey colour. Epidote, actinolite, hornblende, specular iron ore, and some other minerals, are also occasionally found in quartz.*

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* In the British Museum there is a piece of quartz about an inch and a quarter in length, which contains a crystal of cyanite.

MARY.

Quartz, I see, is not always crystallized.

MRS. L.

No; but it often assumes remarkable external forms, as well as being found massive and amorphous.

FRANCES.

What is the meaning of *amorphous?*

MRS. L.

It signifies without form; that is, without any regular form or crystallization. Sometimes it is pseudomorphous, which means having a false form; this is, of two kinds: quartz has covered or invested other substances, which have since been decomposed, leaving hollows and impressions in the quartz in the form of the crystal on which it has been deposited; or it occurs in the form of other crystallized minerals. Here is a specimen, of which the crystals are cubic, and have been produced by deposition in a mould left by fluor.

MARY.

But what is become of the fluor?

MRS. L.

It has been gradually decomposed and removed by the agency of some other mineral substance near it. Here is a pseudomorphous crystal, in the form of the metastatic dodecahedron of carbonate of lime, from Bristol. Swimming quartz is a variety of the other kind of pseudomorphic formation.

FRANCES.

Will it really swim on water?

MRS. L.

It will float as long as the little cavities remain filled with air; for the quartz is so very thin, and the interstices so numerous, that the specific gravity of the mass is less than that of water: but the specific gravity of quartz being about 2.6, as soon as the water has displaced the air, it will sink. That brown specimen is from the Cape of Good Hope; the white one from Cornwall. It is also called cellular, spongy, or cavernous quartz.

FRANCES.

How very delicate the white one is!

MRS. L.

I must request you not to touch that specimen; it is so very brittle, that the slightest pressure on the edges would crush it.

Floatstone, another variety of cellular quartz, is brought from St. Ouen, near Paris.

MARY.

It appears, at first, more compact than the other specimens we have seen.

MRS. L.

That is only because the interstices are smaller, and far more numerous. The centre of some specimens is solid flint, while the outside is quite porous; it is not, however, very pure silica, as it contains a portion of water, and sometimes a small quantity of carbonate of lime*. These are specimens of *massive* common quartz; the lustre of the fracture approaches to oily. This, which is nearly opake, is fat quartz.

MARY.

That is just like the pebbles which I told you I rubbed together, to see the light they produced.

MRS. L.

Any two pieces of quartz would have produced the same effect; and it is curious that they will even do so under water; for the light is by no means the same as that produced by striking a flint and steel together.

Most fat quartz, when rubbed, emits a peculiar and very unpleasant smell: this is not always the case, but some has been discovered near Nantes, in France, which, on being broken, gives out an odour so disagreeable, that Steffens (a celebrated mineralogist) has called it stink quartz. The smell resembles that of the Harrowgate water, or sulphuretted hydrogen.

MARY.

What is that owing to?

---

* CONSTITUENT PARTS.

	Vauquelin.	*Bucholz.*	
Silica	98.0	94.0	91.00
Water	—	5.0	6.00
Carbonate of lime	2.0	—	2.00
Oxyde of iron with alumina	—	0.5	0.25
	100.0	99.5	99.25

MRS. L.

It is supposed that the quartz contains bitumen, which is the cause of a similar smell in black limestone.

Sandstone is a granular kind of quartz, of which there are many varieties. Sometimes the particles are so small, that it is almost compact; these kinds are very hard. Some sandstones are coarse granular; in others, the parts have so little cohesion, that they are friable, that is, may be easily crumbled. The most remarkable is a flexible kind, found in Brazil, and at the mountain of St. Gothard in Switzerland. I have a fine specimen from Brazil, above 18 inches long; you may lift up either end of it without taking it out of the drawer.

MARY.

How very curious! It bends like a piece of thick leather, but more easily.

MRS. L.

It is not elastic like leather.

FRANCES.

You may lift the end of it two inches from the bottom of the drawer. But it is cut into this form, is it not?

MRS. L.

Yes, it is merely a narrow strip; you would scarcely perceive its flexibility in a large or thick mass. But here is a piece from the Yellow River in China, which, when it has been immersed in water for an hour or two, is not only flexible, but elastic. If you press your finger on it forcibly, it will leave a slight impression; but it will regain its original form in a short time.

FRANCES.

I never saw any thing so extraordinary.

MRS. L.

You may squeeze it like a piece of meat: indeed the sailors who discovered it said it must be petrified round of beef! I believe it is this kind which has been found near Whitby, in Yorkshire.

These specimens are nearly white; but sandstone is frequently stained with yellow, orange, red, brown or purple, and irregularly striped with several of these colours.

MARY.

And what is the colouring matter?

MRS. L.

Iron, which in different states communicates the colour to most earthy minerals. In the red sandstone it is in the state of an oxyde. The yellow colour is owing to a mixture of carbonate with the oxyde. Sand is very often coloured in the same manner.

FRANCES.

But it is sometimes quite white, is it not?

MRS. L.

Very fine sand, almost perfectly white, is found at Alum Bay in the Isle of Wight, on the coast of Norfolk, and at Reigate in Surrey. This kind is used for making glass. The sand cliffs at Alum Bay are very beautiful from the great variety and brilliance of their colours.

The next specimen is rose quartz.

MARY.

What a very delicate pink!

MRS. L.

That is caused by a very minute portion of the carbonate of manganese. This subspecies has never been found crystallized. It occurs in large masses in the granite of Bohemia and Bavaria, in the Hartzberg Forest, and in some parts of North America.

FRANCES.

I should think it would make beautiful ornaments; is it ever used for that purpose?

MRS. L.

Yes: when it is of a deep rose-red, it is cut and polished. The paler varieties, when cut, have a milky appearance, and are sometimes called milk quartz.

MARY.

I think it is not always easy to distinguish milk quartz from massive common quartz. Some of these specimens are very much alike.

MRS. L.

They pass into each other; which is very often the case with two or more subspecies.

FRANCES.

Then it is not necessary that every mineral in a collection should belong to a particular species or subspecies?

MRS. L.

Certainly not. It is useful to have others which are intermediate, to show the connexion between them: besides, you will recollect that all division into families, species, and subspecies, is artificial. It is often difficult, if not impossible, to draw the line of distinction between two subspecies.

MARY.

Here is a specimen, however, which appears to have no connexion with the preceding ones.

MRS. L.

That is avanturine.

FRANCES.

Are those beautiful shining particles, gold?

MRS. L.

No; they are scales of mica, a mineral better known by the name of Muscovy talc. The rich reddish brown colour of the quartz in which they are disseminated, makes them appear very brilliant.

MARY.

Yes; but it is very much improved by polishing.

FRANCES.

The mica in this red specimen is in extremely small scales, so that they appear like bright points;

and the natural specimen is almost as beautiful as the polished one.

MRS. L.

That is a different kind of avanturine: the bright particles are not mica, but merely the effect of numerous very small fissures in the quartz, which reflect the light from the internal surfaces; just as you see where a pane of glass has been cracked, by the reflection from the surface of the fracture. This variety, which is the most valuable, is brought from Spain. It occurs of several different colours; yellowish, greenish, greyish, and reddish-white—sometimes flesh-red and pale crimson; and it has been found at Glen Fernat and Fort William, in Scotland. The next mineral you are already acquainted with in a *cut* state; it is cat's-eye.

FRANCES.

I have seen a great many cat's-eyes polished, but this has a very different appearance.

MARY.

It looks much better in the rough state. I think, when polished, it hardly deserves to be called a precious stone.

MRS. L.

It is nevertheless much admired in England, but is still more highly prized by the East Indians, who consider it as an amulet against bad eyes, and give an immense price for the large ones.

FRANCES.

That is something like the prejudice respecting amethysts.

MRS. L.

There is scarcely any country where superstition has not attached miraculous properties to particular stones and plants. The Indians attribute certain virtues to most of the precious stones; but I believe they consider the cat's-eye as superior to the others. For this reason, very few of the large ones are brought to England.

MARY.

Most of these are larger than any I have seen before;—here is one above two inches long.

FRANCES.

Does it ever crystallize?

MRS. L.

No: it has never been found otherwise than in rolled pieces.

MARY.

What is the cause of the opalescence?

MRS. L.

The fibrous texture of the mineral. It is not like the structure of amethyst; for in cat's-eye the fibres are so very fine, that it approaches to compact, and the fracture is small and imperfect conchoidal. Fibrous gypsum and satin spar, when polished, exhibit nearly the same appearance. The opalescence has been supposed by some to proceed from a mixture of amianth with the quartz. Here is a polished piece of quartz, containing grey amianth, which was found in the Hartz; but amianth contains magnesia, and none has been discovered in cat's-eye.

MARY.

But I suppose this is not pure silica, or it would be transparent like rock crystal.

MRS. L.

No; it contains a small quantity of alumina, lime, and oxyde of iron.*

FRANCES.

In what part of India is it found?

MRS. L.

In the islands of Ceylon and Sumatra; also in Persia, Arabia, and on the coast of Malabar. It varies in transparency, but always has the same silky lustre and opalescence.

MARY.

Is this dark green stone a cat's-eye too? It appears slightly opalescent.

MRS. L.

No; that is a small piece of prase, cut in the form usually given to cat's-eye.

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*

Silica	95
Alumina	1.75
Lime	1.50
Oxyde of iron	0.25
Loss	1.50

Klaproth.

FRANCES.

Is it a kind of quartz?

MRS. L.

It is quartz containing actinolite, so intimately mixed with it, that at first it has the appearance of a simple mineral. I have several specimens which show the two substances differently intermixed. In this one the quartz is transparent, and you may see the thin crystals of actinolite within it.

FRANCES.

Yes; they are very distinct: they are a good deal like the crystals of iron in the Bristol quartz.

MRS. L.

Actinolite is generally of a dark green, but these radiated crystals are particularly dark.

When the mixture of the two substances is very complete, prase is of a leek-green colour. The fracture is not exactly the same as that of quartz, but approaches to splintery. The transparence depends on the quantity of actinolite which it contains; but it is seldom more than translucent on the edges. There are very few minerals for which you will be likely to mistake it.

MARY.

Then it does not pass into any thing else?

MRS. L.

Nothing, except rock crystal or quartz; it is not an abundant mineral. You should remember, among the other characters, that the fragments of prase, and all the other subspecies of quartz (except sandstone), are sharp-edged; they are least so in cat's-eye. And all these substances will give sparks with steel.

MARY.

Then, could you use them instead of flint?

MRS. L.

Yes; but they would not answer the purpose quite as well, because they are more brittle than flint. The second species is ferruginous quartz, or iron-flint*.

FRANCES.

Is this red specimen iron-flint? It is very much like jasper.

MRS. L.

Being polished, you cannot easily perceive the difference; but if you compare the fracture of the two substances, you will see that the fracture of jasper is dull; but there is considerable lustre in that of iron-flint.

MARY.

Yes; it is interspersed with very minute shining particles.

MRS. L.

There is less of that appearance in some of the brown and yellow varieties, which are more compact.

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* Iron-flint is a literal translation of the German Eisenkiesel.

FRANCES.

Here are several shades of brown, but they all approach to yellow. Is not this fracture conchoidal?

MRS. L.

Yes; but in some specimens it passes into uneven and fine granular, particularly in the red ones: but you have looked only at the massive varieties; here are some, crystallized.

MARY.

What a confusion of little crystals! they appear to be cemented together by the same substance.

MRS. L.

That yellow specimen is very fine, the crystals are so large and distinct.

FRANCES.

Yes; I see the crystals are, in general, not much larger than pins' heads,—but some of these are above a quarter of an inch long.

MRS. L.

In this specimen you may see a beautiful gradation from pure quartz to iron-ochre. Some of the crystals are quite transparent and colourless; others contain small quantities of the ochre in the centre of them; and where there is very little silica, the fracture is earthy.

MARY.

Will this strike fire with steel?

MRS. L.

Yes, except in the part where the ochre predominates. The specific gravity varies from 2.6 to 2.8 : the quantity of iron is different in different specimens, which is most probably the cause of this variation.*

FRANCES.

What is this glassy-looking mineral?

MRS. L.

That is hyalite. It is very much like quartz; but it contains 6⅓ per cent of water, and does not crystallize.

MARY.

How very smooth and bright the external surface is!

FRANCES.

It looks like a quantity of gum-arabic half dissolved. I cannot see any fracture; it is spread so thinly over this brown rock,—and in little round masses.

MRS. L.

Here is a specimen on which the hyalite is as large as peas: the fracture of it is small conchoidal, and it is a very brittle substance.

* CONSTITUENT PARTS.

Silica	93.5	... 92.00	... 76.83
Alumina	—	... —	... 0.25
Oxyde of iron	5.0	... 5.70	... 21,66
Oxyde of manganese	—	... 1.00	... —
Volatile matter	1,0	... 1.00	... 100

MARY.

How do you distinguish it from quartz?

MRS. L.

Pure quartz never occurs disseminated on another mineral unless when crystallized. The specific gravity of hyalite does not exceed 2.46, which is owing to the quantity of water it contains.

FRANCES.

What kind of rock is this? it appears to me like lava.

MRS. L.

It is called trapp.

MARY.

What a strange name!

MRS. L.

It is a Swedish word, meaning a step or stair, which has been adopted by mineralogists to signify a rock which has a form somewhat resembling steps. It is often vesicular, as in this instance; and sometimes other substances occur in the cavities. Some trapp rocks contain zeolite; others agate, opal, or carbonate of lime, and many other minerals. In several of its characters, hyalite resembles opal more than quartz, and it is therefore placed next to it. There are several kinds of opal; the first is that so much valued in jewellery—precious opal.

MARY.

I think it is the most beautiful mineral in the world;—look at this exquisite green.

FRANCES.

I cannot see your green; but this specimen shows brilliant flashes of crimson and pale purple.

MRS. L.

The colour of opal, independent of the reflected light, is generally milk or blueish white; but when held between the eye and the light, it appears of a pale muddy yellow. I think you will admire this specimen very much,—it is opal disseminated in small particles through grey porphyry.

MARY.

I think it is even prettier than the pieces of pure opal.

FRANCES.

Is opal brittle? it appears to be full of little cracks.

MRS. L.

Yes, it is very brittle: one of the finest specimens in the world, which was for many years in the imperial cabinet at Vienna, was lost by being exposed to the rays of the sun, in order to exhibit its brilliancy to the greatest advantage: the heat expanded the air contained in the little cracks, and it broke to pieces.

FRANCES.

What a pity!

MRS. L.

The two next subspecies, common and semi-opal, are entirely without the beautiful play of colours which is characteristic of precious opal.

FRANCES.

Is this semi-opal?

MRS. L.

No, that is common opal: it is as transparent as the precious variety, though not equally beautiful; and it contains less water.

MARY.

Does precious opal contain more water than hyalite?

MRS. L.

Yes, it consists of 90 parts of silica, and 10 of water; but some varieties of common opal are without water *.

In the fracture of semi-opal the lustre is generally waxy, and it is often dark-grey and brown; and more rarely it occurs of a dull greenish yellow. None of the colours are bright, so that I do not expect you to admire these much at present; but to a mineralogist this is a very interesting series, as it shows the connexions between the three subspecies,—the common and sem-iopal pass into each other.

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* CONSTITUENT PARTS.

	Common opal of Kosemütz.	Common opal of Telkobanya.
Silica	98.75	93.50
Alumina	0.10	—
Oxyde of Iron	0.10	1.00
Water	—	5.0

Klaproth.

FRANCES.

Is this red specimen, common opal?

MRS. L.

No, that is a much scarcer mineral, called fire or sun opal—if you look *through* it, you will see that it is very transparent; but looking down on it, you will perceive a peculiar iridescence—you must let the sun shine on it, for it requires a bright light.

FRANCES.

I see a green colour in the interior of it.

MARY.

And a bright red,—not like the general colour of the mineral, but quite a crimson.

MRS. L.

These are the only two iridescent colours of fire opal; it is mostly of a hyacinth red colour.

FRANCES.

You said it was a scarce mineral; where is it found?

MRS. L.

Excepting a specimen that was raised many years ago from High Rosewarne mine in Cornwall, we are acquainted with only one locality of fire opal, which is Zimapan in Mexico. In South America the precious variety has been discovered: until lately it was found only in Hungary.

MARY.

Are any of the other varieties found in England?

MRS. L.

Several specimens of common opal have been brought from Cornwall.

FRANCES.

What are these little bits of white mineral, quite dull and opake,—surely not opal?

MRS. L.

It is a kind of opal called hydrophane, from its property of becoming semi-transparent by immersion in water.

MARY.

I should like to see that experiment.

MRS. L.

Here is a glass of water,—you will see the effect produced, in a few minutes.

FRANCES.

What a stream of little air-bubbles rose from it when you put it in!

MRS. L.

It is very porous, and therefore the water is quickly absorbed, and displaces the air—for the same reason it adheres slightly to the tongue:—try it.

FRANCES.

I confess I do not like the sensation.

MRS. L.

You see the pieces in the glass are rapidly losing their opacity.

MARY.

One of them reflects beautiful colours, like those in precious opal.

MRS. L.

Hydrophane is probably common or precious opal deprived of part of the water it contains; for it is very similar to those parts which have lost their transparency by exposure to the air.

MARY.

What is the specific gravity of opal?

MRS. L.

The specific gravity of all these subspecies varies from 2.00 to 2.18. The variety called mother-of-pearl opal, or cacholong, is rather heavier; the specific gravity is not lower than 2.20.

FRANCES.

How very delicate that blueish white colour is!

MARY.

Some parts of it are yellowish white and opake; is it all cacholong?

MRS. L.

Yes; that opacity has been caused by exposure to the atmosphere. This kind has not been analysed, but it appears probable that it is an intimate mixture of calcedony and zeolite: it is frequently striped or banded, as in this specimen, one of the bands being much more transparent than the other. Here is a still better example: one half is semi-transparent calcedony; the other is fibrous zeolite, and quite opake.

MARY.

The colour, then, is owing to the calcedony, and the opacity to the zeolite?

MRS. L.

Yes.

FRANCES.

Is cacholong found in England?

MRS. L.

I believe not; but it occurs in Scotland, Iceland, the Faroe Isles, and in many of the rocks in which calcedony and opal are found.

MARY.

Is not this a specimen of petrified wood?

MRS. L.

Yes, it is wood converted by the process of petrifaction into a kind of opal; it always occurs in the form of stems and branches of trees, though not any of the original substance remains.

FRANCES.

But in this piece you may see the part that has once been bark; and how very distinctly the grain of the wood is preserved.

MRS. L.

In the grey specimen it is shown by the dark concentric rings; but you can scarcely perceive, at first, that this yellowish one is wood opal.

FRANCES.

The lustre of wood opal seems to me very different from that of the other subspecies; it appears as if it were gummed.

MARY.

Here are some curious-looking minerals.

MRS. L.

They are menilite:—there are two kinds of it, grey and brown.

FRANCES.

Is it not a kind of semi-opal?

MRS. L.

No; it is now considered as a distinct species, though it has been at different times arranged with opal, jasper, and pitchstone. It always occurs in these small tuberose masses, which appear connected together, as if it had been poured into the adhesive slate (in which it is imbedded) in a liquid state.

MARY.

Is this the *grey* menilite?

MRS. L.

No; that is the brown:—the external surface of both kinds is bluish grey, but the fracture of this is greenish brown—in the other kind it is light grey. The form of the concretions, also, is different—the masses of grey menilite appear compressed, and the surface is smoother than in the brown variety.

FRANCES.

Is not the fracture foliated?

MRS. L.

The term foliated is applied only to those minerals which have a crystalline structure—this is slaty. It does not, however, *always* afford a slaty fracture; for it is sufficiently compact to be broken in other directions,—and in this case the fracture is conchoidal.

The grey menilite is found in an argillaceous marl at Argenteuil, a little to the south of Paris, and at St. Ouen, not far distant; but the brown variety occurs only at Menilmontant, to the north of Paris.

The sixth species is called siliceous sinter.

FRANCES.

What is the meaning of sinter?

MRS. L.

It is a German word, which signifies a stalactite or incrustation, apparently formed by the trickling of water. You have seen stalactites in the caves of Derbyshire.

FRANCES.

Yes; they hang like icicles from the roofs.

MRS. L.

Those are formed by deposition from water containing carbonate of lime.—Siliceous sinter is produced by the Geysers and hot springs of Iceland, which contain a considerable quantity of silica.

MARY.

Is quartz, then, soluble in hot water?

MRS. L.

Not at the surface of the earth; but the water of the Geysers is considerably hotter* than boiling water, and contains a small quantity of alkali. This substance is not always stalactitic; but though it assumes various forms, it still retains the name of sinter.

FRANCES.

I think this is what you term botryoidal; it appears bubbled, like the hyalite.

MRS. L.

Yes, that is one of its most common forms; it occurs also coralloidal, and resembling moss: the large masses of this kind have exactly the appearance of cauliflowers growing around the Geysers. The porous varieties generally contain vegetable substances,—for they are formed *beyond* the basins from which the Geysers rise, by the falling water. Here is a specimen full of little bits of straw and small stems, which seem to have been entangled in it.

MARY.

This is similar to the effect produced by the petrifying springs at Matlock.

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* The water of these springs, boils at the surface of the earth; but the temperature must be considerably higher than 212° in the interior of the earth, where it is subjected to compression.

MRS. L.

The term petrifying is applied incorrectly to these springs; they only *incrust* the substances thrown into them.

The sinters formed *within* the edge of the basins are more compact, and are reddish white, light red, and various shades of grey.

MARY.

That light red one is striped like agate.

MRS. L.

When it has the appearance of having been formed by several successive depositions, arranged in layers, it is said to consist of lamellar concretions. One variety of siliceous sinter is opaline, and sometimes marked with black and bluish grey spots.

FRANCES.

The fracture is very shining, but I do not know how to describe the kind of form.

MRS. L.

It is intermediate between fibrous and uneven.

MARY.

Here is a prettier specimen than any of those you have shown us: the outside is pearly.

MRS. L.

That is pearly siliceous sinter: it differs a little from the other subspecies in composition, and the form is generally stalactitic, or appears to be an agglomeration of small globular masses.

FRANCES.

Are these substances as hard as quartz?

MRS. L.

Not quite—but they will scratch glass with case. The pearl sinter was discovered at the foot of the hill of Santa Fiora, in the island of Ischia, whence it has been called fiorite.

FRANCES.

I suppose the specific gravity of these is rather low?

MRS. L.

Yes; it varies from 1.80 to 1.91.

MARY.

I am glad to see some flints: I have been expecting them for some time.

MRS. L.

It is a substance so well known, that it will not be necessary for me to say much about it. I have a good many specimens, to show the peculiar forms, and different colours of which it occurs.

FRANCES.

I see here are some containing quartz crystals. I remember finding some once in breaking flint pebbles.

MRS. L.

It is not at all uncommon to find them lining the cavities of flint.

MARY.

What are the whitish substances in some of these specimens?

MRS. L.

They are petrifactions of alcyonia, fungi or sponges, which do not in general fill the cavities in which they are situated. The outside is usually rough and nearly white; but if you break them, you will find that they are internally of the same colour as the surrounding mass: petrified shells, in the state of flint, are often met with. Here is a piece in which a small echinus is imbedded.

FRANCES.

How very perfect it is!

MRS. L.

When flint is of only one colour, it is most commonly grey, or brownish yellow; but variegated flints often present brighter colours arranged in spots and stripes, either straight or curved.

The fracture of flint is always perfect and large conchoidal, and the lustre feebly glimmering, sometimes dull in the more opake varieties.

MARY.

What is the reason that these dark flints are chiefly white externally?

MRS. L.

In some the white crust has been produced by exposure to the atmosphere, others are in their original state.

There are immense beds of flint in the chalk cliffs, on the south coast of England, in the form of irregular nodules, which often have a white crust.

Pebbles are frequently imbedded in a coarse sandstone, forming a mineral known by the name of pudding-stone.

FRANCES.

I have seen some of this before, cut and polished: the red pebbles are really very much like plums.

MRS. L.

A great deal of this conglomerate is found in Hertfordshire. Flint passes into calcedony and carnelian, which often line the cavities in botryoidal or tubercular forms. This is particularly the case in the flints of Dorsetshire, and the western termination of the chalk stratum. Flint passes also into conchoidal hornstone, which you see is placed next to it. The name hornstone, was first given to the variety which breaks with a splintery fracture, from its slight resemblance to horn; but this kind is more like common quartz than flint. The most common colours of hornstone are reddish white, milk white, and very light grey, sometimes stained with dull yellow.

FRANCES.

Some of the splintery hornstone is marked with small irregular dark spots.

MRS. L.

That is probably chlorite. Hornstone sometimes occurs in supposititious crystals, which most commonly have the form of carbonate of lime, or fluor; and it very frequently appears in the form of madrepores. It may be distinguished from flint by its inferior hardness and want of lustre.

FRANCES.

Does the composition of it differ from that of flint?

MRS. L.

It is most likely that it does: but I do not know that it has yet been analysed. Wood is often found petrified by hornstone, and is then called woodstone.

MARY.

How beautifully some of these specimens are marked with scarlet and crimson!

MRS. L.

Those are from India. The woodstone of Warwickshire and Bedfordshire is mostly brown; that from the Isle of Portland is nearly white, and contains quartz crystals in the rifts. These are specimens of calcedony; and carnelian, which is considered as a subspecies of it.

FRANCES.

What is the difference between them?

MRS. L.

If you examine them, you will see that the fracture of calcedony, though generally conchoidal or even, approaches to splintery, and is quite dull; but in carnelian the fracture is conchoidal, and faintly glistening, particularly in *red* carnelian.

MARY.

Is not this pale blue crystallized substance calcedony?

MRS. L.

Yes; the crystals are similar to the primitive rhombs of quartz; it also occurs in pseudomorphous cubic crystals: but all these are rare. It is generally large botryoidal, or it forms layers in agate balls. The rarest colour is a light green, which occurs only in India.

Here is a small stalactitic semitransparent specimen, covered by quartz crystals which radiate from it.

MARY.

What is this very dark brownish mineral, nearly opake?

MRS. L.

That is carnelian in its natural state.

MARY.

But are not all these in their natural state?

MRS. L.

All, except the dark red ones; they were originally like this, but have acquired their beautiful colour and transparency by exposure to heat: they are burnt in large earthen, or iron pots; an operation which is performed before they are exported from India.

FRANCES.

But carnelian is found in other countries, is it not?

MRS. L.

Yes, carnelian pebbles are abundant in Arabia, Surinam, Siberia, Bohemia, and many other places: they are mostly light red and yellow (sometimes variegated), and do not require burning. It is rather softer than calcedony.

MARY.

Here is a specimen, like a piece of melted bottle-glass: the external surface is quite bright.

MRS. L.

That is plasma from the ruins of Rome, where most specimens of it have been found.

FRANCES.

Here is a very large piece.

MRS. L.

No, that is heliotrope, commonly called bloodstone, from the red spots of jasper it sometimes contains; but these are not essential to it. It is an intimate mixture of calcedony and a substance called green earth (which you will not see just yet).

MARY.

It has a much finer colour than plasma or prase.

MRS. L.

In general it is only translucent on the edges; but I have some beautiful specimens in which the mixture of the two substances is not complete; and being cut thin, they are very translucent. And here is one, where the green earth is dispersed through the calcedony like moss. The colouring matter is iron.

FRANCES.

These are very interesting.

MRS. L.

The last I showed you was brought from Abyssinia by Lord Valentia. Heliotrope occurs in Bucharia, Tartary, Siberia, Scotland, and some other places. The Siberian varieties contain no red spots. Chrysoprase is another very beautiful subspecies of calcedony, which you will readily distinguish from every other mineral by its colour.

MARY.

What a refreshing green! Is this caused by iron?

MRS. L.

No; that colour is produced by the oxyde of nickel, of which it contains about one per cent.[*] The green is a little bluer than that of emerald. In fracture, chrysoprase resembles calcedony, but it never has a botryoidal form, being always found in small veins, which it completely fills up, as you

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[*] Calcedony.		Carnelian.	Plasma.	Heliotrope.	Chrysoprase.
Silica	99	94.	96.75	84.	96.16
Lime	—	——	——	——	0.83
Alumina	—	3.50	0.25	7.50	0.08
Ox. iron	—	0.75	0.50	5.00	0.08
Ox. nickel	—	——	——	——	1.00
Water	—	——	2.50	——	——
Loss	1	1.75	——	——	1.83

may see by the roughish brown exterior of these specimens.

FRANCES.

I see some Egyptian pebbles. What are they called in mineralogy?

MRS. L.

They are jasper, another species in this large family, which is subdivided into several kinds. Here is a variety, which from its resemblance to the Egyptain pebbles has been called red Egyptian jasper, though found only at Baden. The colour is in general a light brownish red.

MARY.

Are these pebbles found in any country besides Egypt?

MRS. L.

No; they occur there, loose in thes and; and their original geognostic situation is unknown. Common jasper is generally massive, and frequently intersected by small veins of quartz, as in these specimens, which are Sicilian.

FRANCES.

I had always fancied that jasper was red, like this; but I see you have some of a fine ochre-yellow.

MRS. L.

Here are also brown and green: but the scarcest kind is black jasper. This substance is always opake or very slightly translucent on the edges. Jasper sometimes consists of alternate layers of different colours; that consisting of leek-green and purplish red is found only at Orsk, in Siberia. Porcelain jasper is supposed to be a pseudo-volcanic production; that is, it has been converted into a kind of porcelain by the action of heat, though it has not been melted in the manner of lava: it occurs in the neighbourhood of those places where volcanoes or beds of coal have burnt. It is only the lead grey and lavender-coloured specimens that have any degree of lustre: the red and yellowish varieties are dull.

FRANCES.

Is it ever found in England?

MRS. L.

Yes; it occurs in considerable quantity between Wednesbury and Bilston, in Staffordshire, one of the coal districts of England; but it is more abundant in Saxony and Bohemia. Jasper, when intimately mixed with quartz or calcedony, is called agate jasper: it would perhaps be better to call it jasper agate, and to consider it as an agate, for it is not a simple mineral.

MARY.

And is not agate a simple mineral?

MRS. L.

No; agates consist of flint, quartz, amethyst, calcedony, hornstone, jasper, heliotrope, and cacholong; and are differently named, according to the different manner in which the substances are arranged: generally, only two or three occur together.

The principal kinds of agate are, striped, brecciated, fortification and moss agate. Striped agate is in general composed of jasper and calcedony; sometimes of jasper and amethyst.

FRANCES.

How very beautiful this is; the layers are so extremely thin and close.

MRS. L.

The largest and finest specimens of this kind are brought from Saxony, where there are very considerable veins of it. The middle of one of these veins contains this kind, called brecciated or ruin agate.

MARY.

That is very curious; it is all composed of little pieces of striped agate and amethyst.

MRS. L.

It appears at first sight like an artificial specimen; but the parts have been actually broken and cemented together by nature. Fortification agates you have often seen: a great part of those called Scotch pebbles are of this kind.

FRANCES.

Some of them are very much like plans or fortifications; but those forms are much more distinct where the calcedony is transparent and the lines dark.

MRS. L.

In many of the dark agates the colour has been produced, or at least deepened, artificially.

MARY.

How is that done?

MRS. L.

I believe it is generally effected by boiling them in sulphuric acid.

FRANCES.

But I thought that silica was not at all soluble in any of the acids?

MRS. L.

Neither is calcedony acted on by them; but agates consisting of different layers often contain carbonaceous depositions of bitumen, which by exposure to acids are in some degree burnt, and change colour, as any vegetable substance will, if acid be poured on it; particularly sulphuric.

MARY.

Do agates then contain vegetable substances?

MRS. L.

Very often. In moss agates, Dr. M'Culloch has not only discovered them, but even ascertained the genus to which they belong. Here is a thin slice of fortification agate, which I attempted to darken by heating it in acid, and you see that some parts have been completely dissolved.

FRANCES.

Yes; here is a layer between those of white calcedony, which has been decomposed, and has left some openings in your specimen.

MRS. L.

I shall not detain you with these agates now; you can examine them by yourselves equally well; and they will be an evening's amusement for you.

The last species nearly resembles flint; but though the fracture of small pieces is conchoidal or splintery, the structure of the large masses is slaty.

FRANCES.

What is it called?

MRS. L.

This kind is called flinty slate; but there is a subspecies named Lydian stone, which is distinguished from it by its darker colour and opacity.

MARY.

This black specimen, I suppose, is Lydian stone?

MRS. L.

Yes; but it is sometimes an extremely dark green. The colours of flinty slate are generally grey or reddish brown, and it is often intersected by quartz veins. Lydian stone was formerly much used as a touchstone, to ascertain the purity of gold and silver.

FRANCES.

I do not understand how it could be useful for such a purpose.

MRS. L.

It is not by any chemical operation; but simply by drawing the metal across the surface of the stone, and comparing the colour of the trace with that of the pure metals, or alloys, which we know contain the proper proportions. These minerals are not quite so hard as flint.

I am afraid you are tired of the quartz family, for it is the most extensive in the whole system; but if any other contained as many species, it would not detain you so long as this, because I have explained many things to you from these specimens which I shall not have occasion to mention again; and as siliceous substances, particularly quartz, occur with almost every other mineral, and under various appearances, I have made a very large collection of them.—To-morrow, we will look at the garnet family and some others.

CONVERSATION VII.

MRS. L.

You must not expect to see much beauty in the minerals of this family.

MARY.

Does it contain many species besides garnet?

MRS. L.

Yes, several; but very few possess the fine colour which renders precious garnet fit for ornamental purposes.

FRANCES.

These deep red crystals are, I suppose, precious garnet?

MRS. L.

Yes; the primitive form is the rhomboidal dodecahedron; but it is very often modified by truncations on the edges. (Plate IV. fig. 50 and 51.) This mineral is said to be the carbuncle of the antients. The species called pyrope is often employed in jewellery; but it may be distinguished from precious garnet by its want of crystallization: it always occurs in roundish grains, which are sometimes imbedded.

MARY.

Are these pyropes, Mrs. L.?

MRS. L.

No; they are precious garnets, imperfectly crystallized. I value the specimen because it is from the Arctic regions, lately explored by Captain Parry [*].

MARY.

What is this green mineral?

MRS. L.

That is a crystal of precious garnet, enveloped in chlorite; here is a similar one broken, which shows the small conchoidal fracture[†] and shining lustre: these crystals sometimes occur three or four inches in diameter.

FRANCES.

But are these *precious* garnets? They are nearly opake, and the lustre of this one is quite metallic.

MRS. L.

They are not fit to be used as jewels: but they are considered as precious garnets in mineralogy, differing from the others in their depth of colour. The metallic lustre is occasioned by the quantity of iron contained in that one: in some countries,

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[*] Numerous specimens of gneiss containing precious garnets were brought from lat. 67° 12′ N., long. 82° W.

[†] The garnets of Canada and Greenland have a foliated fracture.

this kind, and the massive common garnet, are worked as ores of iron.

MARY.

That is the reason, I suppose, that it is so heavy?

MRS. L.

Yes; the specific gravity of precious garnet varies from 4.08 to 4.3; that of common garnet is generally about 3.7. Common garnet crystallizes in the same forms as precious garnet; but the colour passes from nearly black, through various shades of brown and dull green, to a pale hyacinth-red. It sometimes forms veins, and is then amorphous or massive, with a fine-grained uneven fracture.

FRANCES.

Are these small bright yellow crystals, common garnet?

MRS. L.

No; that mineral is called, from its colour, topazolite: it was at first considered as a variety or subspecies of garnet; but it has been found to contain a small quantity of the earth glucine, and only 2 per cent of alumina. It has been found only at Mussa, in Piedmont. All these minerals are sufficiently hard to scratch quartz.

MARY.

What are these very little blackish crystals?

MRS. L.

They are pyreneite, on limestone; their form is the rhomboidal dodecahedron, and none of them are modified. These yellowish green translucent crystals are called grossular garnets, or grossularia, from their resemblance, in colour, to a green gooseberry (groseille).

FRANCES.

How do you distinguish them from the green crystals of common garnet?

MRS. L.

The planes of the grossular garnet are with very few exceptions, smooth; but those of the common garnet are streaked in the direction of the edges of the dodecahedron. Their composition too is very different, grossular containing above 30 per cent of lime: in this respect it resembles the next species, allochroite, which you might at first mistake for massive common garnet.

MARY.

Is it possible to find out with which of the two species a mineral should be arranged, without analysing it?

MRS. L.

Yes: allochroite is not so hard as quartz, and when fused by the blowpipe, with the addition of phosphate of soda, it melts into a kind of enamel, which is at first reddish yellow; afterwards becoming greenish, and finally black. Precious and common garnet melt before the blowpipe pretty easily, and so does colophonite.

FRANCES.

Is this granular mineral colophonite?

MRS. L.

Yes: it very seldom occurs crystallized; generally consisting of numerous shining, angular grains, which are easily separated from each other.

MARY.

In transparency and colour the grains have a good deal of resemblance to the light-coloured precious garnet.

MRS. L.

But the specific gravity of this species is less than 3.0, which is a sufficient distinction.

FRANCES.

Are not these black crystals pyreneite as well as the others?

MRS. L.

No; that is melanite or black garnet: pyreneite is more or less translucent, but this is always black and opake. It is remarkable that melanite rarely occurs in primitive dodecahedrons. (Fig. 51.) I have *one* specimen from Sweden, in which the crystals are not modified, but they are small.

MARY.

Are any of the other varieties scarce?

MRS. L.

Yes; allochroite has been found only at Drammen, in Norway, and there not abundantly. Colophonite only in the vicinity of Arendahl in the same country. The pyrope was formerly called Bohemian garnet, from its locality. The finest precious garnets I know of at present, are some which were brought from Greenland by Professor Giesecke a few years ago.

The next species is aplome: it differs from the others both in composition and crystallization, though from its dull olive colour it would appear to belong to common garnet. (Fig. 53.)

FRANCES.

Are the angles of the dodecahedron never truncated in common garnet?

MRS. L.

Never; nor in any of the species except aplome: but the remarkable circumstance in this is, that the planes of the crystals are always streaked in the direction of the shorter diagonals, which indicates the *cube* for the primitive form, though it has not yet been seen. The translucent crystals approach to a deep brownish orange colour.

MARY.

What are these opake white crystals?

MRS. L.

They are leucite; a substance which has, perhaps, but little right to be placed here, as it differs from all the other minerals in this family, in containing 20 per cent of potash; but it is often arranged with these species, and called white garnet.

FRANCES.

Are these the primitive crystals? (fig. 52.)

MRS. L.

Probably not: but it has never been observed to assume any other form; the trapezohedron* may be derived either from the cube or the rhomboidal dodecahedron as a primitive; but neither the surface, nor the fracture of leucite, will assist us in determining which of these belongs to it.

FRANCES.

Is this trapp rock, in which the crystals are imbedded?

MRS. L.

No; that is lava, the most usual repository of leucite: so that it is considered as a volcanic production. Leucite is scarcely hard enough to scratch glass; a character which distinguishes it from another white mineral which has the same crystallization. You may have remarked, that all the crystalline forms of these species are the rhomboidal dodecahedron, either simple or modified.

We now come to the idocrase family †. The first

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* This form has been termed the leucite crystal.

† Idocrase and cinnamon-stone have been in general arranged in the garnet family; but the crystallization of idocrase differing from that of all the species of garnet, I have placed it at the head of a distinct family. It is followed by cinnamon-stone, which Dr. Thompson considers as merely a variety of it. See Thomson's Chemistry, 6th edition, vol. iii. p. 291.

ANALYSES.

	Pyrope*	Precious*	Com.†	Topazolite‡	Pyreneite§	Grossular*	Allochroite‖	Colophonite**	Melanite*	Aplome††	Leucite§
		Garnet.									
Silica	40.	35.75	39.66	37.	43.	44.	37.	37.	35.5	40.	56.
Alumina	28.5	27.25	19.66	2.	16.	8.5	5.	13.5	6.	20.	20.
Lime	3.5	-	-	29.	20.	33.5	30.	29.	32.5	14.5	2.
Magnesia	10.	-	-	-	-	-	-	6.5	-	-	-
Glucine	-	-	-	4.	-	-	-	-	-	-	-
Potash	-	-	-	-	-	-	-	-	-	-	20.
Oxyde of Iron	.5	36.	39.68	25.	16.	12.	18.5	7.5	24.25	14.	-
——— Manganese	.25	0.25	1.80	2.	-	Trace.	6.25	4.75	0.4	2.	-
——— Titanium	-	-	-	-	-	-	-	0.5	-	-	-
Water, &c.	-	-	-	-	4.	-	-	1.	-	-	-
Loss	1.25	0.75	-	-	1.	2.	3.25	0.25	1.35	7.5	2.

Mixture of Silica and Iron 2.

* Klaproth. † Hisinger. ‡ Bonvoisin. § Vauquelin. ‖ Rose. ** Simon. †† Laugier.

species, idocrase or vesuvian, in composition resembles some of the garnets, but the primitive crystal is a square prism. (fig. 54.)

MARY.

Some of these are very complicated. (fig. 57.

MRS. L.

I have endeavoured to arrange them with some attention to crystallization—these detached crystals are but little modified, and very perfect.

FRANCES.

Yes, the planes at both ends are quite smooth. (figs. 55, 56.)

MRS. L.

Those large blackish green ones are from the neighbourhood of the lake Baikal, in Siberia, whence they have been called baikalite; but that name has been given to other substances from the same place. This mineral was first found in the vicinity of Vesuvius. It is accompanied by carbonate of lime, mica, hornblende, common garnet, and sometimes other minerals. The pale green semi-transparent idocrase is from Piedmont.

MARY.

Here is a bright blue specimen: is that idocrase?

MRS. L.

Yes: it is from Tellemarken in Norway. The pink substance which is imbedded in the quartz with it, is called thulite.

MARY.

And what is thulite?

MRS. L.

It has not been analysed.

FRANCES.

Surely, Mrs L., *this* is not idocrase; it is exactly like one of the garnet family—colophonite, I think.

MRS. L.

Not *exactly*, though there is certainly a great similarity between the two substances; but, in composition, cinnamon-stone agrees with idocrase, rather than with garnet. For some years it was only known as occurring in the sand of the rivers of Ceylon, in the form of small rounded pebbles, which were thought to be a variety of hyacinth.

MARY.

But, in these specimens, the cinnamon-stone seems to be intermixed with a white shining substance.

MRS. L.

These are part of a rock in the island of Ceylon, which was discovered a few years ago, consisting of cinnamon-stone, and a mineral called table-spar. I never heard of any crystals of cinnamon-stone except one, in the collection of the Geological Society of Cornwall; which I have seen. It was sent from Ceylon by Dr. Davy—the form is the rhomboidal dodecahedron.

FRANCES.

Is it ever used as a precious stone?

MRS. L.

Yes; but it generally contains numerous very small air-bubbles, which give it the appearance of glass. The next species is gehlenite, so named from Professor Gehlen, a celebrated mineralogist.

MARY.

The crystals appear to be small rectangular prisms; but I am not sure about it—they are heaped together in such confusion.

MRS. L.

They are square prisms (fig. 58.), but there are few minerals which resemble it; the entangled position of the crystals is rather characteristic of it.

FRANCES.

Both your specimens are light grey;—does it ever occur of any other colour?

MRS. L.

Yes; it is sometimes olive green, greenish brown, or blueish black — the fracture is uneven and dull. It is rather heavier than quartz — the specific gravity is about 2.91. Gehlenite will scratch glass, but is not so hard as quartz.—The last member of this family is meionite, or scapolite; for the latter is now considered only as an impure variety of it. The crystals of meionite are colourless, and in general transparent. They are found with green mica and augite, and sometimes white calespar and other substances, on Monte Somma, one of the summits of Vesuvius.

MARY.

These are very beautiful and perfect. I can distinguish square prisms, and others with their lateral edges truncated, without a glass, though they are so small. (fig. 59.)

MRS. L.

The crystals of scapolite have the same form, but are in general, much larger; and their usual colour is pale olive green or light grey.

FRANCES.

These prisms are very distinct; but I do not see any perfect terminations.

MRS. L.

They are more rare in scapolite, than in meionite. The variety termed wernerite is sometimes well crystallized.

MARY.

How silky the external lustre is! it looks a little like cat's-eye.

MRS. L.

That lustre is peculiar to the crystals that are nearly white;—in this specimen they are aggregated in little bundles. The compact scapolite, which is most commonly greenish grey, or pale olive-green, breaks with a splintery fracture: it sometimes occurs of a deep red colour, but this is rare.

MARY.

What is this yellowish green specimen? it is translucent throughout.

MRS. L.

It is a variety called gabbronite; but it does not differ from scapolite, except in having rather more lustre and transparency. Scapolite has received several names; among others, wernerite, in honour of the celebrated mineralogist Werner; and arctizite, from having been first found within the arctic circle.

FRANCES.

It must be considered, then, as very rare. Where are the other varieties found?

MRS. L.

In the province of Wermeland in Sweden, where it is associated with carbonate of lime; and at Arendahl.

	Idocrase*	Cinnamon-stone*	Gehlenite †	Scapolite ‡	Wernerite §
Silica	42.	38.80	29.64	48.	40.
Alumina	16.25	21.20	24.80	30.	34.
Lime	34.	31.25	35.30	14.	16.5
Oxyde of iron	5.5	6.50	6.56	1.	8.
——— manganese	——	——	——	——	1.5
Water	——	——	3.3	——	——
Loss	2.25	2.25	——	5.	——

* Klaproth.
† Fuchs.
‡ Abilgard.
§ John.

MARY.

I see we are at the end of the family; for here are some of my electrical friends the tourmalines.

MRS. L.

They are subspecies of schorl, (the first in the schorl family,) which is divided into precious (or tourmaline,) and common schorl. These may, in general, be distinguished from each other, for common schorl is always black and opake.

FRANCES.

All these brown, blue, and green crystals, then, are tourmaline?

MRS. L.

Yes, and the pink ones, which are sometimes called rubellite.

MARY.

I remember an immense specimen of rubellite in the Museum;—the colour is pale pink, (not very bright,) and I think the crystals are arranged in a radiated form.

MRS. L.

Your description is very correct as far as it goes. It is one of the finest specimens of rubellite known, and is valued at 500*l.* You, perhaps, recollect a short history that is written under it, intimating that it was presented by the King of Ava, to Col. Symes; and it is mentioned by Col. S. in his entertaining account of the Embassy to Ava.

FRANCES.

I recollect it now. Is the primitive crystal of tourmaline a prism?

MRS. L.

No, it is a very obtuse rhomb (fig. 61.), but the crystals are most commonly prismatic, and terminated by 3, 6, 9, or more planes: the flat terminations are very rare. I have a semi-transparent crystal of this form (fig. 67.), partly imbedded in magnesian limestone, from Piedmont, the only place where that kind is found.

MARY.

I should have thought it aqua-marine, or emerald, from its light colour.

MRS. L.

Here is a curious variety, of two colours.

FRANCES.

The outside is green, and the middle bright pink, as if one had been put into the other.

MARY.

And the crystals are cracked across in several places.

MRS. L.

Those are from North America. The crystallizations of common schorl are exactly similar to these, and in both varieties the lateral planes are shining and deeply streaked longitudinally; but the planes of the terminations are generally smooth.

FRANCES.

In some of these crystals the streaks are so deep, that I cannot see how many sides the prism has; it appears almost round.

MRS. L.

That is a very common circumstance. Tourmaline is sometimes radiated; but this is a variety seldom met with. Rubellite and common schorl are very frequently radiated.

MARY.

Are these black crystals common schorl?

MRS. L.

Yes; those are from the neighbourhood of Chudleigh, in Devonshire, and are imbedded in felspar; these more slender crystals, imbedded in white quartz, occur in Sweden. At Roche, in Cornwall*, there are rocks entirely composed of minute crystals of schorl, and roundish grains of white quartz. Common schorl, and the blue, green, and brown tourmaline, are coloured by iron; the red and violet varieties, by the oxyde of manganese, which, it is supposed, is the cause of the infusibility of red tourmaline—the other kinds melt with very little difficulty.

FRANCES.

Are these minerals harder than quartz?

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* Black schorl is disseminated through all the granites of Cornwall, from Mousehole, to the Land's End.

MRS. L.

The hardness of quartz and tourmaline is about equal. Some crystals of tourmaline, which appear nearly, or quite transparent, when you look though them are opake in the direction of the axis—Here is a dark blue one, which is a very good example of this phenomenon. I have had it cut into the form of a cube, so that it is not the greater thickness of it in any direction that renders it opake.

MARY.

How curious this is! looking in the direction of the axis, I cannot see the least light—what is the reason of it?

MRS. L.

The tourmaline and some other minerals possess the property of producing a new arrangement in the particles of light which fall on them, and are said to have the power of polarizing it: in some instances, as here, the light is entirely intercepted. This substance also, has a curious effect on light.

FRANCES.

Is it not blue tourmaline?

MRS. L.

No; it is a much less abundant mineral, called iolite, or dichroite. In general it appears of a muddy violet, or indigo blue; but, if you look through it in the direction of the axis of the crystals, the colour is very different.

MARY.

That is very surprising.

FRANCES.

In this direction it is a pale yellowish brown or grey.

MRS. L.

I have some small crystals of it from Massachusetts imbedded in cleavelandite—some of them are light blue, and nearly transparent.

MARY.

How could I distinguish them from blue tourmaline without detaching a crystal to see the two colours?

MRS. L.

The lateral planes of this substance are never longitudinally streaked as they are (with very little exception) in tourmaline; and the fracture is generally, uneven; but in tourmaline it is conchoidal. The primitive crystal is a hexagonal prism (fig. 67.)—these are twelve-sided prisms (fig. 68.). This very dark blue variety is called indicolite.

FRANCES.

The fracture is nearly radiated.

MRS. L.

The specific gravity, of both kinds, is about 2.5, and they will both scratch quartz with some difficulty. The massive translucent iolite is accompanied by pyrites.

MARY.

Is this pyrites? it looks like brass.

MRS. L.

Yes. This mineral was formerly considered as blue quartz.

FRANCES.

Here is a specimen that I think might be easily mistaken for quartz; it is quite transparent, and the fracture conchoidal.

MRS. L.

That is a subspecies called steinheilite; but it differs so very little from iolite, that some consider it merely as a variety. It occurs, as here, imbedded, or rather disseminated, through a mixture of felspar, mica, and other substances, in small detached masses. I have never seen any that was not amorphous. There is another mineral of this kind, called peliom, which, both in composition and external character, appears to agree with iolite, so that I see no reason for making a distinction between them. It is said to occur only at Bodenmais, in Bavaria. Steinheilite is found in Finland. I do not think you will have much difficulty in recognising these minerals when you see them again.—Axinite, the last species in this family, is also very well characterized. It is of a clove-brown colour, very pale in some of the transparent varieties, and sometimes approaching to pearl grey; but the translucent crystals are deep brown, inclining to purple.

FRANCES.

How very thin and flat the crystals are.

MRS. L.

It has been called axinite, in reference to its form, the edges being thin and sharp like the edge of an axe. The primitive, which is a right prism with rhombic bases (fig. 69), has, I believe, been obtained only by cleavage. Some of the crystals are rather complex, but these are the most common (figs. 70, 71, 72).

MARY.

The external surface is exceedingly brilliant, though some of the planes are deeply streaked.

MRS. L.

Though it admits of cleavage, the indications of a foliated fracture are very indistinct; the fracture is generally uneven.

FRANCES.

I do not understand these crystals, they are so unsymmetrical.

MRS. L.

The want of symmetry in the crystalline forms of axinite, is accompanied, as in the tourmaline, by the property of becoming electric when heated.—It is said that symmetrical crystals sometimes occur, which are not electric; but I have never seen any. Small dark crystals occur in Cornwall, but I never saw any that exceeded three quarters of an inch in length, and they are uncommon of that size. The large transparent ones are from Dauphiné, and it occurs in Saxony and the Pyrenees. The green colour and opacity of some of them are occasioned by the intermixture of chlorite.

FRANCES.

Has the blowpipe any effect on it?

MRS. L.

Yes; when it is heated (either alone or with borax) it melts into a hard black enamel. The epidote family, which follows, contains but two species, epidote and zoisite.

MARY.

Are these large green crystals epidote? (figs. 74, 75, 76.)

MRS. L.

Yes; its most common colour is deep yellow-green; and the large crystals and massive epidote are only translucent on the edges. The primitive

	Green	Red	Black Schorl†	Iolite‡	Axinite*
	Tourmaline *				
Silica	40.	42.	36.75	42.6	44.
Alumina	39.	40.	34.50	34.4	18.
Lime	3.84	—	——	1.7	19.
Magnesia	——	—	0.25	5.8	—
Potash	——	—	6.0	——	—
Soda	——	10.	——	——	—
Oxyde of iron	12.5	—	21.	15.	14.
——— manganese	2.	7.	Trace.	1.7	4.
Loss	2.66	1.	1.50	——	1.

* Vauquelin. † Klaproth. ‡ Dr. Leopold Gmelin.

form is a right prism, of which the bases are oblique-angled parallelograms (fig. 73), but they are rarely, if ever, found without modifications.

FRANCES.

The transparent crystals are streaked, like the tourmalines; but I do not think I should mistake one for the other—these are a much yellower green.

MRS. L.

The colour is not so good a distinction as the crystallization. You will not find it so easy to distinguish it from some varieties of idocrase: and this too has received the name of baikalite, as well as some other appellations,—thallite, acanticone; and from the resemblance of its colour to that of the pistachio-nut, pistacite.

MARY.

What is this light green granular mineral?

MRS. L.

That is a variety of epidote, which is also called scorza; it differs from the other only in form. The light green spots on the surface of this specimen are aggregations of very delicate acicular crystals of epidote, radiating from a point.

FRANCES.

They are as thin as hairs.

MRS. L.

Yes, it would be impossible to determine their crystallization. Here is a substance apparently very different from these, which is considered as a subspecies of epidote.

MARY.

What is the cause, then, of its purplish brown colour?

MRS. L.

The oxyde of manganese, of which it contains about 12 per cent. The crystallization and fracture are the same as in common epidote, but it is more opake, and is not so hard, yielding to a knife; common epidote scratches glass.

Zoisite very much resembles epidote in some respects, and the constituent parts are nearly the same, but its colour is generally blueish or yellowish grey, sometimes inclining to brown.

FRANCES.

I think the fracture is brighter than in epidote.

MRS. L.

The most distinctive character of zoisite, is the manner in which the prismatic crystals are aggregated, like a parcel of reeds beside each other, and sometimes slightly diverging. It has but one cleavage, which is parallel to the axis of the prism, and in the direction of the shorter diagonal of the base.

If you think these minerals are sufficiently impressed on your memory, we will just look at the pitchstone family.

MARY.

I shall know them better after I have seen them once more at some other time; but at present, I confess that so many green minerals have made something of a confusion in my head.

MRS. L.

Green is the most abundant colour in the mineral kingdom, except grey, therefore I do not wonder at your being a little puzzled with what you have seen; and it is practice only that will enable you to distinguish the different shades which appear nearly alike. However, there is but one green substance in this family—pitchstone.

FRANCES.

What are these black specimens?

MRS. L.

Obsidian.

Epidote.	From the Valais.	From Oisans.	Zoisite.
Silica	37.0	37.0	45.
Alumina	26.6	27.0	29.
Lime	20.0	14.0	21.
Oxyde of iron . .	13.0	17.0	3.
——— manganese	0.6	1.5	—
Water	1.8	3.5	—
Loss	1.0	.0	2.

MARY.

How exactly it is like black glass!

MRS. L.

Yes; and it resembles glass in its composition, containing from 7 to 10 per cent. of alkali; but this is not sufficient to render it as fusible as glass.

MARY.

Will it not melt before the blowpipe?

MRS. L.

Some kinds will; but heat has a very curious effect on some obsidian: the black obsidian of Iceland melts into a pale grey vesicular glass; but that from Peru loses its colour entirely, becomes spongy and fibrous, and is converted into pumice.

FRANCES.

What are the constituents that could produce this effect?

MRS. L.

It is most likely that gas is evolved during the operation; but of what kind, has not been ascertained. This is rather an abundant mineral, and in some countries is applied to useful purposes. In Mexico and Peru, mirrors are made of it; and as it breaks readily into thin, sharp-edged pieces, the natives use it for razors.

MARY.

They would have the advantage of retaining their sharpness longer than steel, I suppose?

MRS. L.

Yes, but obsidian is very brittle, so that little bits would soon be shivered from the edge. The mountain in Mexico, where it occurs so abundantly, is called la Serra de las Novagas (the Mountain of Knives). The natives of Easter Island make the points of their spears and arrows of it; and it is found in Siberia, Iceland, and most volcanic countries. The blue and light grey obsidian is almost transparent: the blue variety is very rare, and found only in Mexico. It scratches glass, but is not so hard as quartz. In some of the South American obsidian there is a beautiful silvery light, partaking of the grey colour of the mineral: this kind is much valued for snuff boxes and other ornamental purposes*. It is sometimes striped.

FRANCES.

It looks exactly as if it had been melted.

MRS. L.

Many distinguished mineralogists consider it as a volcanic production, and its being found chiefly in volcanic countries (and sometimes accompanied by lava), seems to authorise this opinion; but others maintain its aqueous origin.

MARY.

Are these little brown pebbles, obsidian, Mrs. L.?

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* The Emperor of Russia, when in London, purchased small slabs of this substance for a snuff-box, for which he paid £300.

MRS. L.

They are a variety called Marekanite, and occur at Marekan, in the Gulf of Kamschatka, from the size of a pea to that of a nut; and mixed with fragments of the same, form a kind of vitreous sand.

FRANCES.

They have very much the appearance of having been melted.

MRS. L.

Pitchstone resembles obsidian in this respect: some of its varieties might be mistaken for the slag from an iron-furnace.

MARY.

These, for instance; but their lustre is not so great as that of obsidian, and they are more opake.

MRS. L.

The conchoidal fracture of pitchstone is in general less perfect than that of obsidian; and in those dark green ones from the island of Ascension, where it is the most perfect, there is a slight degree of roughness which is very peculiar.

FRANCES.

Yes, but there is none of that roughness in this one.

MRS. L.

That has almost a slaty structure; it is from Newry in Ireland. In the pitchstone of the island of Arran, the fracture passes into uneven and coarse splintery; and a great deal of it contains little specks of felspar, and minute vesicular cavities.

MARY.

I should have taken these yellowish and reddish white specimens for semi-opal.

MRS. L.

Pitchstone frequently passes into semi-opal, and sometimes into jasper, as in this ochre-yellow specimen. Blue is by far the rarest colour of this mineral, and yellow pitchstone is rather scarce. It is found abundantly in Hungary and in Saxony; also in Ireland and Scotland, but not in England.

The next species is pearlstone.

MARY.

Why is it called pearlstone?

MRS. L.

The specimens most characteristic of the species have a strong resemblance to greyish pearls, in their lustre, colour, and form. I should rather say, to a *mass of pearls*; for it consists of opake distinct concretions, in the form of somewhat angular grains, varying from the size of coarse sand to half an inch or more. If you examine those grains that are broken, you will see that they each consist of concentric coats or layers, like a bulbous root.

MARY.

Yes; this is not like any thing I have seen, so I think I shall remember it.

MRS. L.

Spherulite is the only mineral which resembles it; and it is sufficiently distinguished from that by its lustre, and the form of the grains.

FRANCES.

Is this spherulite?

MRS. L.

Yes; the distinct concretions of this substance are always spherical, from which circumstance the name is derived. Observe, too, that the specimen is not composed entirely of spherulite; but the little round masses are imbedded in pitchstone or pearlstone; sometimes singly, sometimes aggregated together. All these four species seem to be intimately connected; their composition is very nearly the same, and two or three of them are generally associated together. Pearlstone and spherulite are less hard than pitchstone. The blowpipe has a still more violent effect on pearlstone than on obsidian or pitchstone, causing it to become spongy and fibrous, and increasing it to many times its original bulk; for this reason it has been supposed that pumice was originally one of these substances, altered by the action of volcanic heat.

MARY.

Is pumice found in volcanic countries?

MRS. L.

Yes; great quantities are exported from the Lipari Isles to England and other places; and it occurs in two islands of the Grecian Archipelago, in Mexico, and in Iceland. Common pumice you are acquainted with; but you have probably never seen the kind called glassy pumice.

FRANCES.

From the name, I suppose *this* is it.

MRS. L.

Yes; you see the vesicular cavities are very round.

MARY.

It is like a froth of soap-suds petrified.

MRS. L.

Grey is its only colour, but instead of having a faint silvery lustre, like the common pumice, it is strongly shining and vitreous. Don't touch it; for it is extremely brittle. The specific gravity does not exceed 1.444, and sometimes is only 0.37, so that, like the vesicular quartz, it will swim on water, till the air in the cavities is displaced.

	* Obsidian.†		Pitch-stone.‡	Pearl-stone.§	Pumice‖
Silica	72.	78.	73.	77.	77.5
Alumina	12.5	10.	14.5	13.	17.5
Lime	——	1.	1.	—	——
Oxyde of iron . .	2.	2.	1.	2.	1.75
——— manganese	——	1.6	0.1	—	——
Potash }	10.	6.	——	2.	3.0
Soda }			1.75	0.7	
Water	——	——	8.5	4.	——
Loss	3.5	1.4	0.15	1.3	0.25

* Collet, Descotils (America).
† Vauquelin (Serra de las Novagas).
‡ Klaproth (Meissen).
§ Vauquelin (Mexico).
‖ Klaproth.

CONVERSATION VIII.

MARY.

I BELIEVE the zeolite family is the next?

MRS. L.

Yes; and I think you will be pleased with it; for all the species occur crystallized, unless karpholite be excepted; but there is great reason to believe that all those shining delicate fibres are crystals.

FRANCES.

Those radiated yellow tufts, then, are karpholite?

MRS. L.

Yes; it has never been observed of any other colour than deep straw-yellow. The fibres are minute and easily separated, and it is easily reduced to powder.

MARY.

It seems to be opake.

MRS. L.

I believe it is completely so.

FRANCES.

What effect has the blowpipe on it?

MRS. L.

It is almost infusible before the common blowpipe, owing, perhaps, to the quantity of manganese it contains; but the blowpipe supplied with oxygen, melts it into a brown opake enamel. You will, most likely, never try the experiment, for it is a very scarce substance, having been found only at Schlackenwald in Bohemia, and very sparingly.

MARY.

Here are some more green minerals—what are they?

MRS. L.

Prehnite; it is of two kinds, radiated and foliated. I think you will not mistake the foliated prehnite for any of the green minerals you have seen.

MARY.

No; this is a beautiful bright green, and not quite so blue as that of chrysoprase.

MRS. L.

The fracture, too, is very different; in one direction it is foliated, and the folia are a little curved. The primitive crystal is a rectangular prism (fig. 77.): the most perfect example of this is the variety called koupholite, which is found in the valley of Barèges, in the Pyrenees.

FRANCES.

How very thin these crystals are!

MRS. L.

When one dimension of a crystal is much less than the other two, it is said to be a table, or to have a tabular form. I have some very good ones which are nearly transparent, and of a greenish-white colour. Some of the crystals are hexagonal. (fig. 78.)

MARY.

But, Mrs. L., I cannot see any crystals in this large specimen.

MRS. L.

Not any *single* crystals—but you see the edges of a number of crystals closely aggregated. That kind is brought from the Cape of Good Hope, where it was first discovered by Col. Prehn, after whom it was named prehnite.

FRANCES.

What are these small shining green masses adhering to the surface of this specimen?

MRS. L.

They are foliated prehnite: the concretions consist of folia diverging from a line, like the leaves of a book half open; so that the surface is somewhat cylindrical or conical, and the fracture is both foliated and radiated. Fibrous prehnite consists of delicate acicular crystals, forming almost spheres, radiated from their centres; and the colour is often grey. Both kinds become electric by heat, and are scarcely hard enough to scratch glass; but this is rather the harder.[*]

MARY.

Is prehnite found in Great Britain?

MRS. L.

Fibrous prehnite is found at Glasgow, in the neighbourhood of Edinburgh, and at several other places in Scotland.

The greenish-white mineral which is found in India and Persia, and generally known by the name of oriental jade, is now considered to be a compact variety of prehnite. It is much valued in the East, and carved into vases and the handles of daggers.

FRANCES.

I believe I have seen it—I think at the Museum there is some. Is it not translucent?

MRS. L.

Yes; rather strongly.

---

[*]

	Karpholite *	Foliated † prehnite.	Radiated prehnite.	
Silica	37.53	50.	42.875‡	43.60§
Alumina	26.48	20.4	21.500	23.00
Lime	——	23.3	26.500	22.33
Magnesia	——	0.5	Trace	——
Oxyde of iron	5.64	4.9	3.	2.00
——— manganese	17.09	——	.250	——
Water	11.36	0.9	4.625	6.40
Loss	1.90	——	1.250	2.67

* Steinman. † Hassenfratz. ‡ Gehlen. § Dr. Thomson.

MARY.

Is this prehnite, too?

MRS. L.

No. This is a very scarce substance, called sodalite; it was first brought from Kanerdluersuk, in West Greenland, by Professor Giesecké a few years ago, and has since been discovered on Vesuvius: its colour is always pale green, and it is generally crystallized in the form of garnet dodecahedrons, which are imbedded in white felspar: sometimes it is disseminated through it in small irregular angular masses.

FRANCES.

Is it hard?

MRS. L.

It is about as hard as felspar; that is, intermediate between quartz and glass. There are several minerals, which, having a particular and unvarying degree of hardness, are very useful as fixed points in the scale, by which others may be compared. Dr. Thomson, who first analysed this mineral, named it from the quantity of soda which he found in it.

MARY.

How much does it contain?

MRS. L.

From 25 to 27 per cent. Natrolite was also named, from the quantity of this alkali, as one of its constituents.

FRANCES.

How so?

MRS. L.

Formerly, soda was called natron. However, this is very different from sodalite: it is most commonly known as occurring in a botryoidal form, with a very compact fibrous fracture, and the fibres diverging.

MARY.

And is it always of this ochre-yellow colour?

MRS. L.

Generally, when it is botryoidal; and there are narrow stripes of a lighter colour parallel to the external form. But here is a specimen of a deep orange-colour—almost scarlet. The other kind is exactly similar in its appearance to the crystallized varieties of the two next species, skolezite and mesolite: they all occur in acicular crystals, which are, generally, four-sided prisms, terminated by four-sided pyramids. (fig. 79.) Sometimes two, sometimes all four of the lateral edges of the prism are truncated, and, occasionally, two edges of the pyramid. (figs. 80, 81, 82.)

FRANCES.

But these bright transparent crystals are not acicular?

MRS. L.

No; but crystals of that size are very rare; the prisms are above the eighth of an inch in thickness. The most common form of these two substances is a radiated aggregation of fibres, which at their free extremities are crystallized; but very often the conical, or wedge-like masses which they form, intersect each other, filling up all the little spaces in them, so that no crystallization takes place, as in these specimens.

MARY.

Yes, like a number of stiff brushes.

MRS. L.

Both these minerals, the crystallized natrolite and the following species, Thomsonite, were, till lately, much confused, under the name mesotype; but their composition being very different, they are now considered as distinct species. Skolezite, in place of the soda which exists in natrolite, contains lime; and mesolite appears to be a mixture of the two.*

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* The mineral, named ekebergite, appears to resemble mesolite, in composition, more than any other substance: it is composed of silica 46; alumina 28.75; lime 13.50; soda 5.25; oxyde of iron 0.75; water 2.25;—3.50 was lost. It is described as a greenish-grey mineral, translucent on the edges, having a two-fold cleavage, but never crystallized. Sometimes the fracture has a broad radiated appearance from the position of the folia: lustre, shining or glimmering; scratches glass, and strikes fire with steel. Specific gravity 2.746.

FRANCES.

But how can I possibly distinguish them, for these all appear very much alike, except that, in some, the fibrous fracture is more delicate and silky than in others? They are all radiated, pearly, and translucent, or semi-transparent.

MRS. L.

I do not know that it would always be possible, without analysing, to distinguish them, unless you knew the locality of the specimens, which would materially assist you. The reflective goniometer can be used only when you have good crystals, as the cleavages are very imperfect, except in a massive variety of skolezite, which occurs at Pargas in Finland. Skolezite may be known from the others by its twisting and curling up when exposed to heat.

MARY.

I suppose then that they are all found in different parts of the world?

MRS. L.

That is not exactly the case; crystallized natrolite has been observed only at Burntisland in Scotland, in Suabia, and at Auvergne in the south of France; skolezite, in Pargas, Iceland, Staffa*, and the Faro Isles; and mesolite occurs in all these islands, in Bo-

---

* I think it very likely that the delicate hair-like fibres in the cavities of the basalt and trapp rocks of Ireland are the same substance, these rocks being similar to those of Staffa.

hemia and the Tyrol. Thomsonite* (so called by Mr. Brooke, in honour of Dr. Thomson) has been found only at Kilpatrick, in Dumbartonshire, and the crystallization is different from that of the other species. (fig. 83.) It is not uncommon to meet with some of these substances deprived of their water of crystallization, and then they are opake, without lustre, and have a powdery appearance; for which reason they have been called mealy zeolite.

The next mineral is stilbite, or foliated zeolite.

FRANCES.

There seem to be two kinds of crystals on this specimen. Which is the stilbite?

---

*

	Natrolite.	Mesolite.	Skolezite.	Thomsonite.
Silica . .	48.0	47.0	46.5	36.8
Alumina .	26.5	25.9	25.7	31,36
Lime . .	——	9.8	14.2	15.4
Soda . .	16.2	5.1	——	——
Water .	9.3	12.2	13.6	13.0
Magnesia				.2
Peroxyde of Iron				.6

The analyses of natrolite, mesolite, and skolezite, are the results of a series of experiments made by Professors Fuchs and Gehlen (which occupied them three years) on the different kinds of zeolite, called by Haüy, mesotype, and by Werner, radiated, fibrous, and needle zeolite.

Angles of the prism of natrolite, 91° 55′, and 88° 55′;—of mesolite, 91° 25′, and 88° 35′;—of skolezite, 91° 20′, and 88° 40′.

MRS. L.

The thin hexagonal plates (fig. 86.); the others are apophyllite. This is its most frequent form; but sometimes the crystals are larger, and thicker in proportion to their size. (fig. 85.) The primitive form is a rectangular prism. (fig. 84.)

MARY.

How delicate and pearly the lustre is!

MRS. L.

Yes, that is very characteristic of it; the crystals, too, are generally a little curved in the direction of the only cleavage it possesses. It is very brittle—a character which belongs also to the other species; and when exposed to the action of the blowpipe, they first froth violently, and afterwards melt into a white and nearly opake enamel.

All the species gelatinize with acids; and, except stilbite, they all become electric by heat.

FRANCES.

The opposite terminations of the crystals ought then to be different?

MRS. L.

The acicular and radiated crystals (in which they always occur) have never been found with more than one termination*; what the other might be, if free, is not known.

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* The pyramidal end of the crystals is the seat of the positive pole.

These trapezoidal crystals (fig. 90.) are analcime: their crystallization is the same as that of leucite.

MARY.

I think I remember your having said that this form might be derived both from the cube and the rhomboidal dodecahedron.

MRS. L.

Yes, in analcime the primitive form is a cube; and here are some crystals (fig. 89.) which are intermediate between the cube and the trapezohedron.

Analcime is not always white, but often appears of a light ochre-red colour; and chiefly in the numerous little cracks which are seen on the surface.

MARY.

It is very bright, notwithstanding those cracks. Has it any cleavage?

MRS. L.

Yes, in three directions, parallel to the planes of the primitive crystal; but the surfaces produced by cleavage are rather uneven. The specific gravity is 2.24: that of stilbite varies from 2.1 to 2.2. Analcime becomes weakly electric by friction.

FRANCES.

Is this analcime too?

MRS. L.

No, that is chabasite: the crystals are very different from those of analcime. The primitive form is a slightly obtuse rhomb (fig. 91.); but they are more frequently modified. (fig. 92 and 93.) It is about as hard as analcime, scratching glass slightly; but it is softer than felspar: the crystals are generally small and colourless. Chabasite contains 21 per cent of water, which is a greater proportion than in the other species: they both contain soda, but only 2 or 3 per cent of lime.

MARY.

What are these curious white crystals, Mrs. L.? I do not understand them. (fig. 96.)

MRS. L.

That is a specimen of harmotome*, or cross-stone, as it has been called from its peculiar crystallization. Those are not single crystals, but are formed by the intersection of two, similar to this. (fig. 95.) The primitive form is an octahedron, composed of two flat pyramids, whose common base is a square (fig. 94.); but I am not sure that

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*

	Stilbite.		Analcime. †	Chabasite. †	Harmotome. ‡
Silica . .	55.615 *	52. †	58.	43.33	49.
Alumina .	16.681	17.5	18.	22.66	16.
Lime . .	8.170	9.	2.	3.34	—
Barytes .	——	——	—	——	18.
Soda . .	1.536	——	10.	9.34	—
Potash . .	——	——	—		—
Water . .	19.300	18.5	8.5	21.	15.
Loss . .	——	3.0	3.5	.33	2.

* Gehlen. † Vauquelin. ‡ Klaproth.

this has ever been observed in nature: the twin crystals are the most common.

FRANCES.

Here are some little scraps that have crumbled off the specimen: what shall I do with them?

MRS. L.

Do not throw them away; I will heat the shovel; —now you may throw them on it.

MARY.

They are faintly phosphorescent.

MRS. L.

If there were more of them, you would see that the light is greenish yellow.

FRANCES.

What is this mineral? It appears, at first, much more transparent than it really is.

MRS. L.

It is called laumonite, in honour of Mons. Gillet Laumon, who first discovered it in the lead mines of Brittany: it is characterized by its peculiar silky lustre and reed-like form, though it is sometimes crystallized. (fig. 98, 99.) Both these specimens are gummed, though not sufficiently to disguise their own lustre.

MARY.

Then why have you gummed them?

MRS. L.

Without that precaution, they crack, and fall to pieces.

FRANCES.

What is the reason of that alteration?

MRS. L.

It is most probably occasioned by the loss of part of the water it contains; for I believe that immersion in water will preserve it equally well. It is rather a scarce substance.—Dipyre occurs, as in this specimen, disseminated with pyrites, through a dark-coloured steatitic rock.

MARY.

Are these little white masses crystallized?

MRS. L.

Yes; but the crystals are not very perfect. You may see indications of cleavage in some of them parallel to the planes of a square prism. Before the blowpipe, dipyre froths and phosphoresces; a circumstance which is peculiar to it[*]. This is the last species of the zeolite family.

FRANCES.

Let me see—the next is the lazulite family.

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[*]

	Laumonite. *	Dipyre. †
Silica . .	49.0	60.
Alumina .	27·0	24.
Lime . .	9.0	10.
Water . .	17.5	2.
Carbonic Acid	2·5	—
Loss . . .	—	4.

* Vogel. † Vauquelin.

MRS. L.

Yes; it contains but two species, which are always blue.

MARY.

That is lapis lazuli, is it not?

MRS. L.

Yes; it is also called azure-stone; it is characterized by its brilliant azure colour.

FRANCES.

It is an exquisite colour; I never saw any thing like it.

MRS. L.

Except the ultramarine, which is made from it.

MARY.

That is the reason, then, that ultramarine is so much more beautiful than any other blue colour.

MRS. L.

The mode of preparing it is rather curious: perhaps you would like to know how the operation is conducted?

FRANCES.

I should like very much to hear how the colour is obtained from it.

MRS. L.

The azure-stone is first reduced to a coarse powder and heated in a crucible for an hour; then vinegar is poured on it, and in that state it remains for some days. When the vinegar is poured off, the powder is rendered finer by rubbing it in a glass mortar; then it is repeatedly washed with water to free it from the vinegar, and ground on a porphyry or agate slab (in the manner of other colours) till it becomes an impalpable powder.

MARY.

Then it is ready to be made into cakes?

MRS. L.

No; there is often a great deal of iron pyrites disseminated through it, which can only be separated from it by another process. The powder so far prepared is thrown into a liquid mixture of pitch, wax, and linseed oil; and when they are thoroughly incorporated, the mixture is allowed to cool. Warm water is afterwards poured on this, and the whole is well triturated by means of a pestle and mortar. The water becomes muddy, and is poured off, and fresh water is added, which soon appears of a beautiful blue colour. The mixture is in this manner washed several times, the water being of a paler colour every succeeding time, till at last it only appears dingy grey. Each quantity of water being left to subside, blue powders are deposited of different degrees of intensity, and perfectly free from all the impurities, which remain combined with the cement.*

---

*

	Silica.	Alumina.	Lime.	Sulphate of lime.	Oxyde of iron.	Sulphuric acid.	Potash.	Water.	Loss.
* Lapis Lazuli	46.	14.5	28.	6.5	3.0	—	—	2.0	—
† Haüyne . .	30.	15.0	13.5	—	1.0	12.0	11.0	—	17.5

* Klaproth. † Vauquelin.

FRANCES.

This is so strange a process, that I cannot imagine how any one happened to think of it. What is the colouring matter of lapis-lazuli?

MRS. L.

It is not, I believe, yet determined, though many conjectures have been formed respecting it. It is found in rolled pieces in various parts of the East.

Haüyne occurs only in a granular state imbedded in lava: it is not at all like lapis-lazuli.

MARY.

No; I see it is transparent: of course it is a volcanic production. Is it found in all lava?

MRS. L.

No; it has been observed only at Auvergne, Andernach, and in the neighbourhood of Rome. Haüy, in honour of whom it was named, called it latialite.*

The felspar family, which you will see now, is extensive, and contains some beautiful substances. Felspar itself is of several kinds; in its purest state it is called adularia, and occurs in beautiful white crystals (fig. 102. Pl. V.); some of which are nearly opake, and some semi-transparent.

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* The specific gravity of Haüyne is 2.833 according to Gmelin; Neergaard makes it 3.10; and Gismondi 3.33. The specific gravity of azure-stone is 2.7 to 2.9.

FRANCES.

One face of the crystals is deeply streaked in the direction of the longer diagonal; so, I suppose, that this is not the primitive form?

MRS. L.

The terminal plane is the only one which does not belong to the primitive crystal. It is an oblique rhombic prism (fig. 100.), the faces T and that opposite to *l*, inclining equally on the base. The cleavages most easily obtained are parallel to the plane P and the secondary face M. (fig. 101.) The cleavage is more difficult parellel to T; and most so, parellel to *l*.*

MARY.

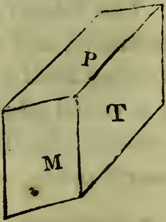
Those streaks, then, do not indicate a cleavage? (fig. 102.)

MRS. L.

No: the cleavage plane passes through the

---

* On this account, Haüy mistook the primitive form of this mineral, and considered it to be a *doubly oblique* prism; the faces being parallel to those marked P, M, T. I have indicated those planes by the same letters adopted by Haüy, for the convenience of my readers who may refer to his figures.



The true primitive form of felspar was lately determined by M. A. Lévy, of the Academy of Paris, and (independently) by Prof. Weiss, of Berlin.

shorter diagonals of the bases at right angles to that face. Adularia is generally crystallized; but sometimes it occurs massive; and frequently it is opalescent, as this polished piece.

MARY.

That blueish light is beautiful. I think I have seen something like this before.

MRS. L.

Yes, I have a little piece set in a ring; you know it is called moonstone.

FRANCES.

This is a brilliant specimen: there are small transparent crystals, and large ones of a milky white colour.

MRS. L.

Those very bright colourless crystals, which till lately were considered to be adularia, are cleavelandite. These are specimens of common felspar, both crystallized and massive.

FRANCES.

That is a beautiful group of reddish crystals: there is a very peculiar glisten in the lustre of them, which I have not observed in any other substance.

MRS. L.

You may observe the same kind of lustre on the cleavage surface in this flesh-red specimen. That crystal in your hand is a macle. (fig. 105.)

FRANCES.

What is the meaning of a macle?

MRS. L.

A crystal which appears as if it had been divided into two equal parts, and one of them turned half round. Suppose, for example, that I divide this crystal (fig. 104.)—at least the wooden model of it, which is made for the purpose—into two parts, by cutting it in the line, a, b, c, d, e. If I turn one part half round, and re-unite them, an angle will be formed at b. (fig. 105.) Do you see that clearly?

FRANCES.

I think I do: but this can only take place in crystals that are unsymmetrical, at least when only the parts *diametrically opposite* are alike.

MRS. L.

You are mistaken, Frances, in your supposition; for the regular octahedron is frequently macled. Here is a macled octahedron (fig. 141. Pl. V.), and a model which will explain it.

MARY.

How curious! The section of the octahedron is a regular hexagon. (fig. 140.)

MRS. L.

Therefore, though in reality one part is turned half round, it appears as if turned only one-sixth of its circumference. This has three re-entering angles.

FRANCES.

That is a very simple example. Are macled crystals of felspar common?

MRS. L.

They are not so plentiful as simple or twin crystals.

MARY.

What are twin crystals?

MRS. L.

They are crystals that occur two together, the one penetrating or intersecting the other. In walking over Westminster-bridge you may see numbers of them from one to three inches long, imbedded in the granite with which it is paved; they are mostly greyish white. Felspar is an essential part of granite, either in crystals or massive; and constitutes the greater part of all porphyries. It is a very abundant substance.

FRANCES.

I think you said it was not so hard as quartz?

MRS. L.

No, but it is much harder than glass: if you try to scratch it with a piece of quartz, you will have some idea of the ease with which it may be done. You see that two cleavages are very distinct, the others imperfect; the fracture in that direction is uneven. One of its most uncommon colours is bright green: this kind is brought from the banks of the Amazon River, in Siberia, and is sometimes called Amazon stone.

MARY.

And what is this white earthy substance?

MRS. L.

It is felspar in a decomposed or disintegrated state: it is employed in the making of porcelain.

FRANCES.

Can this be the same substance as those crystals?

MRS. L.

I believe this kind has not been analysed; but the difference of its texture is conjectured to arise from the loss of the potash, which is a constituent of common felspar.

Felspar, when compact, has so much the appearance of hornstone, that you might easily mistake one for the other; but a very simple experiment will enable you to distinguish them.

MARY.

What is that?

MRS. L.

Compact felspar is fusible before the blowpipe, but hornstone is not. The specific gravity of these minerals is about 2.56. These imbedded crystals are called glassy felspar.

FRANCES.

They appear very much cracked in the direction of the longest side of the crystals. Are they always of this light grey colour?

MRS. L.

I believe they are. At Drachenfels on the Rhine, and in Bohemia, they occur in porphyry; in Hungary, imbedded in pumice. It is merely a variety of felspar or adularia.—The next substance, cleavelandite, is a distinct species; differing from felspar both in composition and form.

MARY.

Why then do you arrange it in this family?

MRS. L.

The differences between cleavelandite and felspar, though quite sufficient to constitute them into two species, do not seem to authorise a further separation.

Their chemical difference consists in the substitution of soda in cleavelandite, for the potash of felspar. That group of large white crystals is from Mount St. Gothard.

FRANCES.

But, Mrs. L., I cannot see any difference between this specimen and some of adularia that we have just looked at. How are they to be distinguished?

MRS. L.

The goniometer will immediately satisfy you of their difference. Two of the cleavages of felspar, parallel to M and P, form a right angle; in cleavelandite they meet at an angle of 86° 30′*.

* Phillips's Mineralogy, 3d edit. p. 378. Lévy, Annals. Phil.

But if you examine the crystals more minutely, I think you will perceive, without that assistance, that they differ from the adularia. Look at these, for example. In the macles of felspar there is not the re-entering angle which is peculiar to the macles of cleavelandite. (fig. 108.)

MARY.

I see that plainly. The re-entering angle appears to be formed by a section parallel to the two faces M of the crystal. (fig. 107.)

MRS. L.

They are from Dauphiné. Those planes are sometimes so broad as to make the crystal appear tabular; but I have never seen any crystals similar to the rhombic prisms so frequently met with in adularia. The surface of many crystals of this substance is very distinctly streaked . . . . . .

FRANCES.

These two minerals seem often to occur together; which I suppose is one reason of their having been mistaken for each other.

MRS. L.

That circumstance and the great similarity of

Jan. 1824, p. 61. The distinction between cleavelandite and felspar was determined by M. Lévy, from the examination of crystals not macled, from Mount St. Gothard.

their form was no doubt the cause. There is another variety, however, which was known to differ in its composition from felspar, before its crystallization had been observed. It was called albite, from its whiteness. This specimen accompanied by quartz is from Finbo in Sweden.

MARY.

That is very pretty. Do you call it radiated?

MRS. L.

It is more properly called palmed, or feathered; the rays diverge as from a stem. When massive, it generally has this structure. The specific gravity of cleavelandite varies from 2.33 to 2.41.

MARY.

Here are some dark grey specimens; are they cleavelandite?

FRANCES.

O no! Look at the beautiful colours they reflect. I believe they are Labrador felspar.

MRS. L.

Yes: Labrador felspar, or labradorite, is the third species of this family.

FRANCES.

What is the cause, Mrs. L., of those brilliant colours?

MRS. L.

They are produced by very minute shining scales or plates, of a mineral called hypersthene.

MARY.

But, in that case, it would be very much like avanturine?

MRS. L.

No, my dear; the scales of mica in avanturine are always large enough to be seen without difficulty; and are disseminated through the quartz without any regularity: but in labradorite, the hypersthene can very seldom be seen without the assistance of a microscope, or, when the scales are particularly large, of a strong magnifier; and they lie in the direction of one of the cleavages, not scattered indiscriminately through the felspar, as the mica in avanturine.

These three species have been minutely examined and described by M. Rose of Berlin; and he mentions a fourth, under the name of anorthite, which he considers, from its composition and crystallographic characters, should be included in the same family*. You will see crystals of it on this specimen, intermixed with green mica, minute crystals of augite, and other minerals, which usually accompany meionite.

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* The incidences of the lateral planes are 117° 28′, and 62° 82′.

FRANCES.

The crystals are so small, and appear to have so many faces, that I really cannot guess from what form they are derived.

MRS. L.

The primitive is a doubly oblique prism: the faces are generally brilliant, and therefore the substance may be identified by the reflective goniometer.—This granular mineral is called Indianite from having been hitherto observed only in the Carnatic: it always contains those little blackish specks, which are hornblende. In hardness, it is intermediate between felspar and glass. These dark green crystals are called gieseckite, from Professor Giesecke, who discovered them at Akullcarafiarsuck, in Greenland: the hexagonal prism is the only form it is at present known to assume, and its colour is deep green.

FRANCES.

It seems to have a cleavage parallel to the terminal planes.

MRS. L.

Yes, there is an appearance of that kind; but it is so scarce a substance, that I am unwilling to run the risk of destroying my specimen by making experiments on it. The light bluish green substance disseminated through this specimen is called spodumen: you see it has a crystalline structure, but does not assume a regular external form.

MARY.

Is it very different from felspar in composition?

MRS. L.

No, they are very similar; the principal difference is, that spodumen contains the newlydiscovered alkali, lithia: its specific gravity is 3.1 or 3.2. Killinite and amblygonite are varieties of this mineral. The former has been observed at Killiney, in Ireland. Elaolite (or fatstone) has also a good deal of resemblance to some kinds of felspar. Dark bluish green is its commonest colour; but it is sometimes flesh-red or grey.

FRANCES.

But it is more transparent than felspar of those colours, and the cleavage I think is less perfect.

MRS. L.

Yes; and the lustre is oily, which is the reason it is called fatstone. Both elaolite and spodumen occur imbedded in the felspar of the West of Norway, which reflects a most brilliant ultramarine blue.

MARY.

That is very beautiful. I suppose it is a variety of labradorite?

MRS. L.

No: that is a true felspar. A mineral called bergmannite, also occurs in this rock; it is described as resembling both elaolite and scapolite in some respects, but is opake. These white crystals are apophyllite. (figs. 109, 110, 111.)

FRANCES.

From their pearly lustre, I should have thought them some kind of zeolite.

MRS. L.

The substance has been called fish-eye-stone, from having that appearance. The primitive is a square prism, and the bases are more pearly than the sides.

MARY.

Are not these, crystals of stilbite with them?

MRS. L.

Yes, they very often occur together; indeed, apophyllite is found in most of the localities of the zeolites. You will see, by comparing the analyses, that all these minerals are composed of nearly the same substances combined in different proportions. The next specimen is petalite, the mineral in which lithia was first discovered.

FRANCES.

It is extremely like fat quartz.

MRS. L.

Yes, but the hardness is not greater than that of felspar; and there is an indistinct appearance of a double cleavage.

MARY.

Is it always white?

MRS. L.

No; you will see a tinge of red and green in some parts.

FRANCES.

I should think it might be mistaken for many other minerals.

MRS. L.

I do not think it is particularly well characterized; but at present it is found only in the mine of Uton, in Sweden. This greyish green mineral is saussurite. There has been a good deal of confusion about the arrangement of it, in consequence of its having received the names of jade, felspath tenace, and variolite.

MARY.

What are these little shining plates imbedded in it?

MRS. L.

They are schillerspar: saussurite and schillerspar frequently occur together, sometimes intimately mixed. Saussurite is much harder than felspar; some varieties will scratch even quartz, and it is extremely tough. In this respect it resembles the common jade; which I have placed next to it.

FRANCES.

Is not this specimen polished?

MRS. L.

Yes; it is a hatchet from one of the South Sea

	* Adularia.	† Common	‡ Compact	‡ ‡ Cleavelandite.	* Indianite.	§ Gieseckite.	Spodumen.		†† Elaolite.	‡‡ Apophyllit	** Petalite.	§§ Saussurite.
		Felspar.					‖	**				
Silica	64.	62.83	68.	68.46	42.5	46.0798	67.5	66.4	46.50	52.	79.212	49.00
Alumina	20.	17.02	19.	19.30	37.5	33.8280	27.0	25.3	30.25	...	17.225	24.00
Lime	2.	3.00	1.	0.68	15.0	...	0.63	...	0.75	24.5	...	10.50
Magnesia	...	...	...	...	...	1.2031	...	...	...	...	...	3.75
Potash	14.	13.00	5.5	...	...	6.2007	...	...	18.	8.1	...	...
Soda	...	...	...	11.27	...	...	...	...	...	...	...	5.50
Lithia	...	...	...	...	...	...	...	8.85	...	...	5.761	...
Oxyde of iron	...	1.00	4.	0.28	3.0	3.3587	3.	1.45	1.	...	...	6.50
——— manganese	...	...	...	...	Trace.	1.1556	...	...	...	...	...	...
Water	...	...	2.5	...	...	4.8860	0.53	0.45	2.	15.	...	...
Loss	...	3.15	...	...	2.0	3.2881	1.34	...	1.50	0.4	...	0.75

* Chenevix.
† Vauquelin.
‡ Godon St. Menin.
§ Stromeyer.
‖ Berzelius.
** Afwerdson.
†† Klaproth.
‡‡ Rose.
§§ Th. de Saussure.

Islands. The natives, who have no iron except what is brought to them from Europe and other civilised countries, value it highly on account of its hardness and tenacity; and, with great labour, form it into tools with which they execute their carvings.

MARY.

Is it always green?

MRS. L.

Deep green is its most usual colour; but it is sometimes paler, and inclines to grey. It is probably much softer when first taken from the earth, or it would be almost impossible for those islanders to cut it.

FRANCES.

Do minerals, then, harden by exposure to the air?

MRS. L.

Not *all* minerals; but many do. Dr. Macculloch, in his geological account of Glen Tilt in Scotland, mentions that he found there, asbestus so soft that it might be moulded by the fingers, like a paste; but which became as hard as wood in the course of a few days*: and this is by no means a solitary instance. It is well known that the Bath limestone may be much more easily cut when first quarried than afterwards.

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* Transactions of the Geological Society: vol. 3.

MARY.

And how do you account for this change?

MRS. L.

It is undoubtedly occasioned, chiefly at least, by the evaporation of water which such minerals contain.

The three species of the next family contain no lime; otherwise they differ less in composition from these than you might expect from their appearance.

FRANCES.

Are they not mica?

MRS. L.

These are not; they are called lepidolite. It is very much like mica, perhaps it ought to be considered only as a variety; but, in general, lepidolite is either of this reddish lilac colour, or silvery white: the white is more opake than mica.

MARY.

The scales of the white specimen are very large, and less heaped together than in the lilac ones.

MRS. L.

The white lepidolite, also called margarite, is crystallized in hexagonal plates. It has the same form as mica; the primitive is an oblique rhombic prism. (fig. 112.)

FRANCES.

I should like to see some crystals of mica. I thought it was found only in the form of scales and plates.

MRS. L.

These small deep yellow crystals are mica. (figs. 113, 114.)

FRANCES.

How beautiful they are! quite of a topaz colour: but I see the same kind of shining surface on the ends of them, as on the large laminæ.

MRS. L.

Mica is a crystalline substance which has but one cleavage; and that is so readily obtained, that the slightest effort separates the crystals into folia.

MARY.

Then, perhaps, these large plates are parts of crystals?

MRS. L.

Certainly they are.—You may observe that most mica (particularly the dark brown and grey varieties) has a semi-metallic lustre. Black and pale pink are, I believe, the most uncommon colours. It is very easily scratched, even with the nail; but the particles of which it consists are so hard that the edges of the laminæ will scratch the hardest glass.

FRANCES.

That is like charcoal: I recollect you said that it had the same property.

MARY.

Is mica ever applied to any use?

MRS. L.

Yes; in Siberia, where it is abundant, and the folia large, the granite is quarried for the sake of the mica, which is used for windows, lanterns, and other purposes to which glass is applied in Europe. Specimens have been sometimes found above two yards square. This yellowish grey variety of mica, in very small curved scales, has been called nacrite, from its strong degree of pearly lustre, which the French call *nacré;* but it does not appear to differ in any respect from mica.

FRANCES.

And what is the specific gravity of these substances?

MRS. L.

That of mica varies from 2.6 to 2.79: the specific gravity of lepidolite is between 2.8 and 2.9.

MARY.

Here is a grey crystal; this is not mica I suppose?

MRS. L.

No; it is pinite. It has some resemblance to mica, both in form and lustre; and in composition, except that it does not contain any alkali.

FRANCES.

This crystal has, I think, twelve sides. (fig. 155)

MRS. L.

Yes; that is from the Puy de Dome, where such crystals are found imbedded in a light coloured, decomposing porphyry. The pinite from Hungary is more friable, and imbedded in white porcelain clay.

We now come to the slates. The first is clay-slate, a very abundant substance, which you, of course, know perfectly well.

MARY.

O, yes; this is exactly like the slates we draw on.

MRS. L.

Some of the prettiest varieties are those found in Cornwall, where it is called killas; they are of different shades of pink, lilac, grey, and light green; indeed it occurs there of almost every colour.

FRANCES.

What occasions the green spots in some of the common slates?

MRS. L.

An intermixture of chlorite. The specimens following are whet-slate, which is known in commerce by the name of Turkey hone, and German hone.

MARY.

They are used for oil-stones, I believe, to sharpen knives;—are they not, Mrs. L.?

MRS. L.

Yes; they are much harder than clay-slate.

FRANCES.

Except this one, of two colours, they do not appear very slaty.

MRS. L.

Their structure, in great masses, is slaty, though the fracture of small pieces is splintery. The name whet-slate was first given to the green and grey varieties from Turkey, but it is now applied to many other kinds of slate, which are sufficiently hard to be used for sharpening knives: they are also called novaculite, from *novacula*, which signifies a knife. The one which you noticed, from its being partly of a yellowish colour and partly purplish-grey, is the German hone; and, in general, the colours are separated by a very straight line, where it often splits. The square of the Royal Exchange is paved with Turkey hones; and at the time of their importation they were considered so valuable, that if any one removed or displaced one of them he incurred a very high penalty. The two species differ considerably in composition: clay-slate contains only from 38 to 48 per cent of silica; but whet-slate, 72.

MARY.

And are these brown specimens slate too?

MRS. L.

Yes, they are alum-slate, from Whitby, in Yorkshire—the black specimens are Norwegian: one of them, you see, contains minute acicular crystals of alum between the folia.

FRANCES.

Is this like the large crystals of alum on the mantlepiece?

MRS. L.

Taste it.

FRANCES.

O, no; that is sour, and not unpleasant, but this is very disagreeable.

MARY.

It tastes likes ink: what is the reason?

MRS. L.

Natural alum contains a small quantity of sulphate of iron, which is a principal ingredient of ink; but it does not exist in the alum of commerce. These little crystals do not always occur in alum-slate, but are the effect of efflorescence, after the specimen has been for some time exposed to the air.

FRANCES.

I had no idea that there were more than one kind of slate. What do you call this piece?

MRS. L.

It is drawing slate; commonly, but improperly, termed black chalk; for it contains neither of the constituents of chalk. Its fracture is often somewhat conchoidal, but earthy; it is soft, and easily cut into crayon pencils, for which purpose it is imported from Italy and Spain. It differs from the other species, in containing 11 per cent of carbon, which causes it so readily to mark paper.

MARY.

I have generally heard it called Italian chalk.—What are the little crystals on this specimen?

MRS. L.

They are sulphate of lime; but that is another kind of slate, called bituminous shale. It contains so much bitumen and carbon, that in the places where it is found, it is used instead of coal: it is generally blackish brown, and the fracture is very straight slaty. At Kimmeridge, in Hampshire, it is called Kimmeridge coal. Some of these specimens contain petrified bivalve shells, which are stained of a beautiful deep orange colour by the oxyde of iron. The last species, adhesive slate, you have already seen with menilite. It is sometimes arranged with the clay family; but from its compactness, and slaty structure, I see no reason for preferring that situation to this.

MARY.

What is it composed of?

MRS. L.

Above one half of its weight is silica.

FRANCES.

Then, why should it be arranged with the clay family?—there is no resemblance between it and clay.

MRS. L.

If the minerals, which are generally called clay, were chiefly composed of alumina, it would doubtless be very absurd; but in reality, most of them contain more silica than alumina. Nevertheless, even when this is the case, they present *the character of alumina*, being, in general, soft and friable: they are, therefore, placed in the siliceous genus, instead of the *aluminous*, which contains those minerals of which above half is alumina.

MARY.

But, Mrs. L., has pure clay, I mean pure alumina, never been found?

MRS. L.

It is always combined with water or sulphuric acid, or both. I believe gibbsite is the purest alumina which has been discovered.

FRANCES.

Is this it, Mrs. L.?

MRS. L.

No; I have not any specimen of it. It consists of about 64 per cent of alumina, and 35 of water; and is said to occur in irregular stalactites, slightly translucent, and of which the structure is fibrous. It is rather singular that it is harder than calcspar.

MARY.

And where is it found?

MRS. L.

At Richmond in Massachusetts, in a neglected iron mine.

FRANCES.

And what is this beautiful white earth?

MRS. L.

It is called porcelain clay, from being used in the manufacture of porcelain. The proportions of the constituents probably vary in different specimens: that from Saxony is said to contain 52 per cent of silica, 47 of alumina, and 6 of oxyde of iron; —it is very nearly like the disintegrated felspar, which is used for the same purpose. It feels very fine, but not soft.

MARY.

No, it has a harsh sandy feel.

MRS. L.

Potter's clay, on the contrary, feels soft and soapy, probably from the silica which it contains being much more finely divided.

FRANCES.

Is not this something like pipe-clay?

MRS. L.

Yes; pipe-clay is the whitest and purest kind of potter's clay.

MARY.

Why is it called pipe-clay?

MRS. L.

Because for a long time it has been used principally for making tobacco-pipes.

FRANCES.

And have you any common clay, such as bricks are made of?

MRS. L.

Yes; it is generally called loam. It varies considerably in its composition as well as its external appearance, being a mechanical mixture of sand and alumina, and generally coloured by the oxyde and carbonate of iron. That in the neighbourhood of London is solid, and of a yellowish brown colour; but some loam, you see, is quite friable.

MARY.

Yes; but if it varies so much as this, I am afraid I shall not often know it when I see it.

MRS. L.

Knowing that it has not any *fixed* character, you will not look for any, but rather recollect the general composition of loam. There is one property, however, which belongs to all the substances in this family,—when you breathe on them they emit a peculiar smell, which is called the argillaceous odour; you may try the experiment with this piece of claystone.

FRANCES.

It is what you would call an earthy smell.

MARY.

It is not unpleasant.—But what is claystone?

MRS. L.

It is merely clay in an indurated state. I do not know that it has been analysed with accuracy, but it contains silica and alumina. It is tolerably hard; so that the fracture is nearly conchoidal. In Upper Lusatia there is a kind of clay very prettily variegated with lilac and different tints of yellow; but one of the most abundant kinds is the slate-clay, or shale.

FRANCES.

Is it this black slaty mineral?

MRS. L.

Yes, it is always black, or nearly so; and very often petrifactions are found in it, both of shells and plants.

FRANCES.

There are some beautiful petrifactions of leaves in this specimen.

MRS. L.

Ferns and reeds are the most common; some of the reeds are extremely large. The small plants generally lie in the direction of the strata, but the largest sometimes stand erect, piercing the strata. One of this kind was observed in Nassau, 40 feet in height, and was a foot in diameter at one of the extremities: but though there is great variety of them, none are like those now existing in a vegetable state. This mineral is found in beds contiguous to the bituminous shale.

MARY.

I dare say I shall remember it.—What is this dusty-looking substance?

MRS. L.

It is called rottenstone; I suppose from its friability. These pieces are from Derbyshire, where it is supposed to have been produced by the decomposition of black limestone, which contains bitumen, and a good deal of alumina. Most of the limestone is removed by the process of decomposition; but sometimes solid pieces are found in the centre of masses of rottenstone. Put a drop of acid on this specimen.

FRANCES.

It effervesces violently.

MARY.

The rottenstone is of a light grey colour, instead of being black like the limestone, in the centre.

MRS. L.

Part of the bitumen, which is the colouring matter, has probably been lost in the decomposition: the mineral is porous, and very light.

FRANCES.

Is it useful for any thing?

MRS. L.

Yes; it is used very extensively for polishing glass and some of the softer precious stones; and the tea-trays, and other articles that are japanned, are polished by means of rottenstone. Tripoli, which is applied to the same purpose, is arranged in this family, though it consists almost entirely of silica.

MARY.

It is somewhat like claystone, except in being so yellow.

FRANCES.

Is it found in Tripoli?

MRS. L.

Yes; it was first brought from that country, which occasioned its name: but it occurs in France, Tuscany, and several other places. This is another mineral also used for polishing, and called polishing slate: it is sometimes friable, and in large masses the structure is slaty.

MARY.

O, dear Mrs. L., I am afraid I shall be sadly puzzled when I see some of these minerals again; they are so much alike.

MRS. L.

Yet there is some difference between all of them. The polishing slate may be distinguished from the species it most resembles, by the alternate layers of white and grey; by its very low specific gravity, its adhesion to the tongue, and the circumstance of its emitting air-bubbles, with an audible sound, when immersed in water. Tripoli presents almost constantly the same characters; and slate-clay differs from them all in its structure, and the vegetable remains which so constantly occur in it. I do not however expect that you should remember them all the next time you see them, after so hasty an inspection. But I think it would be of little advantage to you to spend a great deal of time on them now; you can examine them again at some other opportunity. Before we leave this family, I must mention to you a mineral called kollyrite, which is remarkable from its containing nearly 42 per cent of water.

FRANCES.

What an extraordinary quantity! I wonder how it can be solid.

MRS. L.

It is white or reddish-white, sometimes faintly translucent and nearly dull. It is found in Stephen's pit, at Schemnitz, in Hungary.—I shall show you no more at present, for some of the minerals in the next family are so much like some of these, that you would perhaps be confused. I will give you the analysis of these clays; and, if you like, you can look over them again to-morrow, before we begin the lithomarge family.

	* Porcelain Earth.	†	* Potter's Clay.	‡ Common	‡ Friable	§ Rotten-stone.	‡ Tri-poli.
				Polishing-Slate.			
Silica .	55.	52.	43.5	79.	87.	4.	81.
Alumina .	27.	47.	33.2	1.	0.5	86.	1.5
Lime . .	2.	—	3.5	1.	0.5	—	Trace
Ox. of Iron	0.5	0.33	1.	4.	1.5	—	8.
Water .	.14	—	18.	14.	10.	—	4.55
Carbon .	—	—	—	—	—	10.	—
Sulph. Acid	—	—	—	—	—	—	3.45
Loss . .	1.5	0.67	0.8	1.	5.	—	1.50

* Vauquelin. † Rose. ‡ Bucholz. § Phillips.

CONVERSATION IX.

MRS. L.

I AM inclined to think that this family and the last might very well form but one. However, most of these species contain a portion of magnesia, which is perhaps the best reason for separating them, though in some it may be an accidental constituent. Lithomarge itself is of two kinds; indurated, and friable. The indurated lithomarge is frequently variegated with red, purple, and yellowish tints.

MARY.

Are they occasioned by oxyde of iron, as in jasper, and some other minerals?

MRS. L.

Sometimes the colours may be owing to iron; but the crimson and purple of these specimens is caused by an intermixture of the sulphuret of mercury, which is, in fact, natural vermilion.

The fracture of indurated lithomarge is generally large, conchoidal, and dull; but when it approaches to friable it is scaly, and in some parts shining, as if it had been pressed by a polished surface.

FRANCES.

That appearance seems to belong only to the specimens that are nearly white, and have a sort of fibrous structure. It appears to be very soft.

MRS. L.

It is so, and adheres to the tongue. This property belongs also to the next species, pimelite; it is distinguished by its green colour.

MARY.

There seems to be great variety of it, for you have it hard, and quite earthy, with all the intermediate states.

MRS. L.

It is probably a variety of chrysoprase, as the colouring matter is oxyde of nickel, and both minerals occur together.

FRANCES.

Perhaps, then, it is chrysoprase deprived of some of the water it usually contains.

MRS. L.

It has that appearance, certainly; but according to Klaproth's analysis of friable pimelite, it contains 38 per cent of water, and chrysoprase contains none; so that it is difficult to account for the change that has taken place, if it were originally chrysoprase. The most friable specimens have a light yellowish-green colour. They all feel rather greasy, as well as the lithomarge. Formerly it was supposed, that all the minerals which had this greasy texture contained magnesia (but pimelite does not contain 2 per cent, and many of the clays feel greasy), and figurestone, in which no magnesia has been discovered.

MARY.

Is this carved specimen figurestone?

MRS. L.

Yes; it was called so from being used by the Chinese to carve images, vases, and other things, for which it is well adapted from its softness and sectility.

FRANCES.

I have seen images made of this; but I do not think it is a very pretty looking substance for the purpose; it is exactly like the rice figures.

MRS. L.

Many persons have a mistaken notion that nearly all the Chinese carvings are made of a composition of rice. Rice is sometimes used for the purpose, but the greater part are made of figurestone, generally brown, or greenish white; and frequently the surface is stained of a deeper colour artificially. In Transylvania a flesh-coloured variety is found. You may easily find out whether your carvings are made of this, or of rice, by scraping off a little and putting it on a hot shovel: the rice will smell like burnt bread.

MARY.

I will try as soon as I go home. Are these little dark-brown pieces figurestone?

MRS. L.

No, they are mountain soap, a much softer substance; but some suppose that it is only a variety of the next species, bole: they are both very light, feel soapy, and adhere to the tongue; and very likely, yellow earth is another variety of bole. They all have, in a great measure, the appearance of clay; but the fracture of mountain soap is not quite so dull as that of the others, and the kind commonly called bole is generally red.

FRANCES.

I think you once told me that yellow ochre was an earth—is it like this?

MRS. L.

It is precisely the same thing. This is from Shotover in Oxfordshire; but it is not the *yellow earth* of mineralogists: this contains so large a proportion of the hydrate of iron, that it may almost be considered as an iron ore. Green earth too is used as a pigment, and commonly called *terra verte;* it is very soft, but heavier than the other species. The specific gravity is 2.5 or 2.6; that of bole from 1.4 to 2.

MARY.

It is a fine deep green. I recollect you said it was the colouring matter of heliotrope.

MRS. L.

Here is a mineral which you have often seen.

FRANCES.

Is it fullers' earth?

MRS. L.

Yes; it was formerly much more extensively employed than it has been since the invention of soap. All cloth and woollen stuffs were cleansed from grease with this substance by the fullers, from which circumstance it was named. The best kind is that found in England, and at one time its exportation was forbidden under very severe penalties. Cimolite, which took its name from the island of Cimolia, has been for ages employed in the same way, both there and in the neighbouring countries. It is a variety of fullers' earth.

MARY.

Is this it, Mrs. L., with the impression of a seal on it?

MRS. L.

No; that is called lemnian earth, from its locality in the island of Lemnos, where it is so highly valued that it is dug once a year, with great ceremony, in the presence of the clergy and magistrates.

FRANCES.

And what use do they make of it?

MRS. L.

It is used as a medicine, and has been celebrated ever since the time of Homer as an antidote to poison and the plague. I believe it has not, in reality, the least power of doing either good or harm; yet it is kept in the apothecaries' shops in Italy and some other countries.

MARY.

How strange it is the people should not have found out that it is of no use,—what is the composition of it?

MRS. L.

Nearly the same as that of fullers' earth; it contains rather more silica, and less water.—This is rather an unimportant family, so we will pass on to the hornblendes. The first three species, hornblende, actinolite, and tremolite, are in some respects so much alike, that many mineralogists consider them as varieties of the same substance, their difference being occasioned chiefly by the nature of the minerals in which they are imbedded; but as this cause produces great difference of colour, and even of composition, it will perhaps be better to divide them.

FRANCES.

But would not the form of the crystals decide this question?

MRS. L.

Their crystallization has, ultimately, shown their connexion; but the first crystals of tremolite that were examined, not being very perfect, their angles were found by the common goniometer (which was the only one then known) to differ from those of hornblende and actinolite by, I think, 2 degrees: I speak of the angles of the prism, which was supposed to be the primitive form; for the *terminations* of the crystals were altogether different from those of hornblende. The examination of other crystals has since proved that the primitive form of all the three species is an oblique prism, of which the incidences of the lateral planes are 124° 36′, and 55° 24′, by the reflective goniometer.

MARY.

From what you have said, I suppose these minerals pass into each other.

MRS. L.

Yes, they do, in every respect. Actinolite is intermediate between hornblende (which is generally black, or very dark green) and tremolite, which is always a light-coloured mineral. Actinolite is always green.

FRANCES.

Are there many different kinds of hornblende? I mean the black species.

MRS. L.

No; the massive varieties are called common, and the crystallized, basaltic hornblende; and sometimes, when it forms beds in mountains, it has a slaty structure. The basaltic hornblende is opake, but the other kinds are sometimes faintly translucent on the edges, particularly if the colour incline to green. These crystals (figs. 115, 116, 117) are from Sweden.

MARY.

It seems to have the same kind of glistening lustre that felspar has.

MRS. L.

In massive hornblende the structure is often fibrous, and then it resembles common schorl. Indeed you will often find it difficult to distinguish them.

FRANCES.

But there is no such glisten on schorl, I think.

MRS. L.

No; but that is not always to be seen in hornblende: however, schorl is harder and more brittle. Hornblende is remarkable for its toughness. It is one of the most difficult substances to break, that I am acquainted with; and if you intend to mineralize amongst hornblende rocks, you should get a strong hammer with a whalebone handle, for a common one will very soon be destroyed. It is a very abundant mineral, being a constituent of some kinds of rock, as felspar is of granite.

MARY.

There seems to be great diversity in the appearance of actinolite.

MRS. L.

Yes: it is divided into granular, common, asbestous, and glassy actinolite. The granular kind occurs in crystallized grains of a pale-green colour imbedded in carbonate of lime; but they are generally a good deal rounded, and always translucent. It is sometimes called pargasite, from being found at Pargas in Finland.

FRANCES.

Some of these grains are black, or nearly so; are they all actinolite?

MRS. L.

No; the dark grains are augite, of which you will presently see other varieties. Common actinolite is sometimes crystallized, but oftener fibrous; and in general the fibres are diverging. It has but little lustre, which distinguishes it from glassy actinolite.

FRANCES.

Does glassy actinolite crystallize?

MRS. L.

Yes, those dark-green crystals imbedded in talc are glassy actinolite (figs. 118, 119); the finest specimens of it are brought from Zillerthal in the Tyrol. Here is the asbestous actinolite.

MARY.

It appears softer than the other kinds, and the fibres are curved and disposed in little tufts.

MRS. L.

One variety consists of small capillary fibres of a greenish-grey, or very light dull green colour; and from its resemblance to amianth, it has been called amianthoide; but it differs from that in the flexibility of the fibres.

FRANCES.

Are these minerals as hard as hornblende?

MRS. L.

Common and glassy actinolite are as hard, but more brittle; their hardness is intermediate between felspar and glass. Tremolite is chiefly found associated with calcareous and magnesian minerals; so that it contains a greater proportion of lime than the other species, but no alumina. Common tremolite is by far the most beautiful of the subspecies; it is frequently white; and you see the lustre of the fibrous varieties is very silky.

MARY.

That is really beautiful:—and is the lilac specimen of the same kind?

MRS. L.

Yes, but that colour is very rare; the crystals are generally greenish (figs. 120, 121), and sometimes grey, and slightly translucent. The glassy tremolite consists of long thin fibres, generally parallel, but often bent or waved. I advise you not to touch these specimens, for the acicular fibres or crystals of which it is composed, are so exceedingly thin and sharp, that they easily penetrate the skin; and I once suffered great pain in my fingers for some days, in consequence of taking up a specimen of glassy tremolite.

FRANCES.

I think the word *glassy* is very appropriate to this kind;—are there any other subspecies?

MRS. L.

Yes; here is asbestous tremolite, and a more uncommon kind, compact—it was discovered in Scotland by Dr. Macculloch.

MARY.

I should certainly have supposed it to be marble, if I had found it.

MRS. L.

In external appearance there is some resemblance; but remember that all marbles may be scratched with a knife, and will effervesce with acids, and this cannot.—It is like some other substances, and puzzled me a good deal the first time I saw it. The specific gravity of tremolite varies from 2.77 to 3.0. Actinolite, from 2.5 to 3.4—the asbestous actinolite is the lightest. The specific gravity of hornblende is less variable; it is generally about 3.1. Besides all these divisions, particular varieties of hornblende have been distinguished by the names calamite and carinthine, which, I must say, I think unnecessary.

FRANCES.

Then we have finished this family?

MRS. L.

No; it contains several other species. Diallage is the next: it may, I think, be divided into three subspecies; smaragdite, which is always green; and schillerspar and bronzite, which are generally brown;—the two last are characterized by a semi-metallic lustre.

MARY.

Is the smaragdite coloured by nickel? It is a beautiful green.

MRS. L.

No; the colouring matter is the oxyde of chrome, which is also the colouring matter of the emerald. Smaragdite forms a part of the rock known by the name of *verde di Corsica duro*, which is cut into slabs and columns: it is there intermixed with saussurite. Sometimes it appears to be almost granular. The schillerspar does not contain any chrome, but owes its dark olive colour to oxyde of iron. It is generally in the form of small roundish plates, and frequently imbedded in serpentine.

FRANCES.

Does it crystallize? for I should suppose these surfaces to be produced by cleavage.

MRS. L.

I do not think it assumes any regular external form; but it has one very distinct cleavage—smaragdite has two. Bronzite is very well characterized by its bright yellowish-brown colour and the fibrous appearance of the fracture.

MARY.

It looks as if it might easily be reduced to thin fibres, and this gives it a sort of opalescent lustre.

MRS. L.

Yes; it is very pretty when polished with a rounded surface, like cat's-eye. Anthophyllite and hypersthene are very much like bronzite: here is part of a crystal of anthophyllite imbedded in the same substance.

FRANCES.

How could I know that this is not bronzite?

MRS. L.

It is harder and more brittle than bronzite; and, if you examine it, you will see indications of four cleavages: two are very distinct, but the others less so. This specimen, containing garnets and mica, is from Greenland—they mostly contain mica; sometimes intimately mixed with them.

MARY.

And which is the hypersthene?

MRS. L.

This dark-brown mineral.

FRANCES.

Surely, this has once been wood.

MRS. L.

No, I believe not; though it has so much the

	Common Hornblende.*	Common Actinolite.†	Asbestous Actinolite.‡	Glassy Actinolite.*	Tremolite.		Smaragdite.‡	Bronzite.||	Schillerspar.**	Anthophyllite.††	Hypersthene.||
					Common§	Glassy||					
Silica	42.	64.	47.	50.	59.244	65.	50.	60.	52.	56.	54.25
Alumina	12.	2.7	—	0.75	0.888	—	11.	—	23.33	13.3	2.25
Lime	11.	9.3	11.3	9.75	15.200	18.	13.	—	7.	3.33	1.50
Magnesia	2.25	20.	7.3	19.25	22.133	10.33	6.	27.5	6.	14.	14.
Oxyde of iron	30.	4.	20.	11.	1.311	0.16	5.5	10.5	17.5	6.	24.50
Do. manganese	0.25	—	10.	0.50	1.	—	—	—	—	3.	Trace
Do. chrome ...	—	—	—	3.	—	—	7.5	—	—	—	—
Do. copper ...	—	—	—	—	—	—	1.5	—	—	—	—
Potash	Trace	—	—	0.50	—	—	—	—	—	—	—
Water	0.75	—	—	—	—	—	—	0.5	—	1.43	1.
Do., with carbonic acid ...	—	—	—	5.	0.020	6.5	—	—	—	—	—
Loss	—	—	—	—	0.204	0.01	5.5	1.5	—	2.94	2.50

* Laugier. † Bergmann. ‡ Vauquelin. § Hisinger. || Klaproth. ** Heyer. †† John.

appearance of it, that I am not surprised you thought so: the colour is much darker than that of the other species.

MARY.

And the opalescence is quite a coppery colour. Is it harder, or softer, than the other species?

MRS. L.

It is considerably harder, it will scratch common hornblende, and the specific gravity is 3.39—that of bronzite 3.2, and of anthophyllite 3.1. Hypersthene has been found on the coast of Labrador, both in rolled pieces and imbedded in the felspar; and a variety was discovered by Dr. Macculloch in the Isle of Rum.

I consider the augite family, which is the next, to contain four species, though, as the primitive form is the same in all, some mineralogists call them varieties of *one*; but I think the division is convenient.—Sahlite and common augite are very much alike, and have a great resemblance to the greenish varieties of hornblende.

FRANCES.

And these crystals (figs. 122, 123,) are exactly like the basaltic hornblende.

MRS. L.

Not *exactly*, my dear: both the terminations and the angles of the prism are different; they are 87° 5′ and 92° 55′. The primitive rarely occurs;

but it is determined by the cleavages, which in sahlite are easily obtained, but in augite with some difficulty; consequently the surfaces so produced are very flat and shining in sahlite; but in augite they are uneven, particularly in the direction of the terminal planes; and this is the principal difference between the two substances.

MARY.

This, then, is a piece of sahlite?

MRS. L.

Yes; the crystals of augite are generally small. Those little black ones are found in lava. If you compare them with the crystals of hornblende, you will find the planes of the augite much smoother, and the crystals generally thicker in proportion to their length. Coccolite is merely augite in a granular form—it is sometimes nearly black.

FRANCES.

I see the grains are not imbedded in any other substance, but appear to be compressed together.

MRS. L.

It has less lustre than the other species, but its granular form is a sufficient distinction. The finest specimens I have are from near Arendahl in Norway. It occurs in North America, intermixed with small garnets, and imbedded in table spar. This specimen was brought from Canada, Sixty miles north-east from Quebec. Fassaïte, or pyrgomme, appears to differ from common augite only in the form of its secondary or derivative crystals, which are generally terminated by acute pyramids, and in being of rather a lighter green: but I do not think it has been analysed.

MARY.

Is there no difference in the hardness or specific gravity?

MRS. L.

No, they are all sufficiently hard to scratch glass; but some, rather feebly: and the specific gravity varies from 3.2 to 3.4. The surface of the crystals is generally shining, both in fassaïte and diopside, which is another species, and I think the prettiest of them—it is in general greenish-white and semi-transparent.

FRANCES.

It think it is a good deal like your French prehnite.

MRS. L.

Yes, but the crystallization is so different that I hope you will never mistake one for the other. Diopside is generally accompanied by precious garnets of a bright hyacinth-red colour, and greenish crystallized mica, which have together a very pleasing effect. It was first called alalite by Bonvoisin, who found it at Ala, in the Piedmontese Alps, and he gave the name of mussite to a variety nearly opake which he discovered in the Alp of La Mussa; it is of a greyer colour than the alalite, and the fracture sometimes appears slightly radiated.

MARY.

There seems to be the same kind of connexion between these minerals that there is in those of the hornblende family; I mean hornblende, actinolite, and tremolite.

MRS. L.

Precisely. You will see by the analyses that there is very little difference between them; not more than between the results of different experiments on the same species.

This is the last family in the siliceous genus: the next specimen is a hydrate of magnesia.

	* Augite. †		Coccolite.†	† Sahlite. ‡		Diopside.§
Silica	48.	52.	50.	53.	54.18	57.
Lime	24.	13.2	24.	20.	22.72	16.5
Magnesia. . . .	8.75	10.	10.	19.	17.81	18.25
Alumina	5.	3.33	1.5	3.	—	—
Ox. of iron . . .	12.	14.66	7.	—	2.18	6.
——— manganese	1.	2.	3.	4.	1.45	
Potash	Trace	—	—	—	—	—
Water	—	—	—	—	1.20	—
Loss	1.25	4.81	4.5	1.	0.40	2.25

* Klaproth. † Vauquelin. ‡ Hisinger. § Laugier.

FRANCES.

What is a hydrate? I do not remember having heard of it before.

MRS. L.

It means the combination of an earth, or other simple substance, with water: I say *combination*, because they must be chemically united, not mechanically mixed; which is the case also with the water in all those substances, of which it constitutes an essential part.

MARY.

How very different it is from the common magnesia. This is quite pearly and foliated, like talc.

FRANCES.

It seems curious that, being only magnesia and water, it is so compact—it is strongly translucent too. What is its specific gravity, Mrs. L.?

MRS. L.

It is about 2.33 or rather higher. This is a scarce mineral, having been found only at Hoboken in New Jersey, and at Swinaness in Unst, one of the Shetland Isles. At both these places, the serpentine rocks are traversed in all directions by veins of the hydrate of magnesia. Another species, called magnesite, contains above 50 per cent of silica.

MARY.

This is quite opake and looks earthy, almost like chalk. Is it from the same place as the foliated specimen?

MRS. L.

No: this kind occurs in thin beds between the limestone and calcareous marl near Paris, and in various other parts of France, and in Italy and Spain. It absorbs water readily, swells, and becomes plastic.

The next is the talc family; talc being the first species.

FRANCES.

I remember you told us that talc might be distinguished from mica by being flexible, but not elastic; but when the laminæ are so small as in this specimen, you would not be able to see whether they were elastic.

MRS. L.

Perhaps not: but talc and mica differ in other particulars as well as in their degree of flexibility. If you try to scratch mica, you will feel a harsh grating sensation; but talc is very soft and soapy, yielding to the pressure of the nail with ease; this is the case even with indurated, as well as foliated and earthy talc: besides, the lustre is more pearly than that of mica; and, in general, the colour is white or green.

FRANCES.

This is a beautiful bright green; but I do not see any large folia, like your Siberian mica.

MRS. L.

No; the laminæ of talc rarely exceed a few inches. When it is crystallized, which is more rarely the case than with mica, it has the same form as mica. The substance commonly called French chalk is indurated talc.

MARY.

What occasions the soapy texture of these minerals?

MRS. L.

It is owing to the large proportion of magnesia which they contain. Talc contains about 30 per cent of this earth, and precious serpentine as much as 44 per cent.

FRANCES.

I never heard before of precious serpentine. Here is a specimen like your green slab, which I used to think was marble.

MRS. L.

That is *common* serpentine; and the minerals commonly called Portsoy and Mona marble are varieties of it. You will see specimens of both kinds. Some of the most beautiful pieces are from the Lizard rock in Cornwall. Precious serpentine has no colour but deep green, and is more translucent than common serpentine. When cut into thin slices, some parts are transparent, and others nearly black.

MARY.

That is very pretty; but is it the same substance as this?

MRS. L.

Yes: excepting that the yellowish-green variety is softer, and has a more conchoidal fracture. Both kinds are harder than common serpentine, and have a faint glimmering lustre.

FRANCES.

I think you said that the white spots and veins in serpentine were marble, or carbonate of lime.

MRS. L.

In the green slab which we were speaking of, but not in all serpentine: in the Cornish, for instance, they are steatite; a substance which is very frequently intermixed with it. You can have no idea of the beauty of the serpentine rocks at the Lizard point, and in the neighbouring coves, without seeing them: they are variegated with the most brilliant greens, and different tints of brown and red, and intersected by large veins of steatite, which are generally yellowish-white, intermixed with purple.

MARY.

I think I can imagine their magnificent appearance from these specimens.

MRS. L.

Here is some of the steatite from the same district, but it is in rather a friable state; that from

Saxony is more compact: from its remarkably greasy feel, it has been called soapstone. Probably earthy talc passes into steatite: indeed, there is a considerable resemblance between all the species of this family. This greyish-green mineral, called potstone, appears at first to be a kind of serpentine; but the magnesia which it contains is in the state of carbonate.

MARY.

Is there any particular reason for calling it potstone?

MRS. L.

Yes; on the shores of the lake Como, where it occurs abundantly, quarries of this mineral have been worked for many centuries; it is there turned and cut into pots, jars, and various culinary vessels, which bear exposure to a great heat without breaking, and consequently are used for the same purposes as our metal saucepans; and they have the advantage of not being soluble in any liquid. Ovens are often lined with it; and I have a teapot, and part of a breakfast set, made of potstone.

FRANCES.

It must be a valuable article in that part of the world.

MRS. L.

Yes; being thus manufactured, it becomes an article of commerce, and is exported into the neighbouring countries.

FRANCES.

What is this, Mrs. L.? it is like talc.

MRS. L.

That is foliated chlorite; its crystallization is very peculiar. The little blackish masses disseminated over that specimen consist of a number of thin, hexagonal laminæ, aggregated so as to form frustums of two cones, applied base to base. (fig. 126.)

MARY.

That is really very curious; but the crystals on this specimen are different.

MRS. L.

They are produced in the same way; only that in these, the axis passes through two opposite *angles* of the laminæ, instead of two *sides*. Some of them are split, and show the arrangement of the laminæ. (fig. 127.) Chlorite is not often crystallized, but generally appears to consist of small scaly parts, like talc: when it is more compact, it is often slaty, and sometimes earthy.

FRANCES.

Is not the earthy chlorite the kind that occurs in rock crystal?

MRS. L.

Yes: and it is not always green, like the other subspecies, but sometimes brown and grey. Nearly one half of its weight is oxyde of iron: all chlorite contains a good deal, which seems to be the principal difference between it and talc.

MARY.

Is not this asbestus, Mrs. L.?

MRS. L.

Yes; it is flexible asbestus, or amianth.

FRANCES.

I remember seeing some in the British Museum, and some cloth made of it, which it is said was used formerly for wrapping up the dead bodies before they were burnt.

MRS. L.

It was exceedingly well adapted for that purpose, as it consists of long silky fibres, which resist a great degree of heat: it scarcely melts before the blowpipe. In order to spin it, it is first mixed with linen or cotton thread, which is destroyed when it is burnt in order to cleanse it. It has been supposed that the ancients made the wicks of perpetual lamps from amianth. It is so abundant in Corsica, that it is used instead of tow, or wool, to pack minerals with; and a large quantity was at one time found in quarrying the Anglesea serpentine: the workmen would not believe it was a mineral, but said it was cotton.

MARY.

I suppose they thought it was petrified.

FRANCES.

Is not this another kind of asbestus?

MRS. L.

It is common asbestus, which differs from amianth only in its greater hardness, and want of flexibility: the prettiest varieties, I think, are this sulphur-coloured specimen, and the bright green which occurs in the serpentine of Cornwall. The indurated kind has so much the appearance of wood, that it is called ligniform asbestus.

FRANCES.

Yes, except that besides its woody appearance, it seems to contain a quantity of shining flakes.

MRS. L.

Those shining parts are talc intermixed with it. The structure of all these varieties is fibrous: in this variety the fibres are curved, and it is said to be *promiscuously* fibrous. They are all soft and tough.

MARY.

What is this, Mrs. L.? It is uncommonly light.

MRS. L.

It is another subspecies, called rock-cork: you see there are some little fibres of amianth intermixed with it.

FRANCES.

It is a very curious mineral. I suppose it is quite porous?

MRS. L.

Yes; it will float on water. Here is a variety, not less curious, called rock-leather.

MARY.

Oh! now you are quizzing, I am sure: it is a bit of an old glove.

MRS. L.

Take a magnifying-glass, and examine this end of it: or you may light the candle, and try whether you can burn it.

MARY.

I do see some indication of fibres.

FRANCES.

And it really is incombustible! See, it is only become white.

MRS. L.

The only difference between this and common amianth is, that *here* the fibres are very much interwoven, so that they cannot be separated without tearing them.

FRANCES.

I should like this family much better if some of the minerals were crystallized.

MRS. L.

They are in general so well marked, that they scarcely want a more distinctive character. Steatite, however, sometimes appears in pseudo crystals, similar to those of quartz (fig. 36); and I think this is by far the most remarkable instance of pseudo-

	Talc.*	Common † Serpentine.‡		Precious Serpentine.§	Steatite.*	Potstone.‖	Axestone.**
Silica	62.	31.5	44.	43.07	59.5	39.	50.5
Magnesia...........................	30.5	47.25	44.	40.37	30.5	16.	31.0
Alumina	—	3.	2.	0.25	—	—	10.
Lime	—	0.5	—	0.5	—	—	—
Oxyde of iron......................	2.5	5.5	7.3	1.17	2.5	10.	5.5
——— manganese	—	1.5	1.5	—	—	—	—
——— chrome..............	—	—	2.	—	—	—	0.05
Potash.............................	2.75	—	—	—	—	—	—
Carbonic acid......................	—	—	—	—	—	20.	—
Water..............................	0.5	10.5	—	—	5.5	10.	2.75
Volatile matter	—	—	—	12.45	—	—	—
Loss	1.75	—	—	2.19	2.	—	0.2

* Klaproth. † John. ‡ Vauquelin. § Hisinger. ‖ Tromsdorf. ** Kastner.

crystallization, for both the terminations are perfect; and there is nothing to account for the removal of the quartz by decomposition.

The next two minerals belong to the chrysolite family.

MARY.

I believe chrysolite is a precious stone, is it not?

MRS. L.

Yes; but on account of its softness, it is less valued than some others which are not more beautiful.

FRANCES.

Is it softer than amethyst?

MRS. L.

Yes, it is intermediate in hardness between amethyst (or quartz) and felspar; the primitive form is a rectangular parallelopiped (fig. 128), but it seldom occurs: this crystal is more common. (fig. 129.)

MARY.

The lateral planes, I see, are streaked longitudinally; but if I were to find a small fragment without any trace of crystallization, how could I know it?

MRS. L.

I think it would not be difficult to distinguish it from the minerals it most resembles,—tourmaline, beryl, and grossular garnet. It is softer than any of them, and does not become electric when heated.

FRANCES.

I think the colour would be almost a sufficient distinction, it is such a beautiful bright yellowish-green.

MRS. L.

Do not depend too much on that; it is sometimes a brownish-yellow, and is then very much like some of the phosphate of lime. Olivine was named from its light olive colour, and at present we know of no other. It is neither quite so transparent, nor quite so hard, as chrysolite, though it contains more silica; the colouring matter is iron. Olivine is granular, and usually occurs like coccolite, not imbedded in another substance. Mr. Phillips mentions a solitary instance of crystallized olivine, found in the current of lava which flowed from Torre de Greco to the sea.

MARY.

And what is the specific gravity of these two minerals?

	Silica.	Magnesia.	Lime.	Oxyde of iron.	Loss.
* Chrysolite . . .	39.	43.5	—	19.	—
† Chrysolite . . .	38.	50.5	—	9.5	2.
* Olivine	50.	38.5	8 25	12.	—

* Klaproth. † Vauquelin.

MRS. L.

Chrysolite is 3.4; olivine 3.2, or nearly 3.3. I forgot to tell you that chrysolite becomes electric by friction.

Now I think you have seen quite as much as your memory will retain till we meet again; we shall then look at the ruby family, the first in the aluminous genus.

END OF THE FIRST VOLUME.

Printed by Richard Taylor,
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Fig. 1.

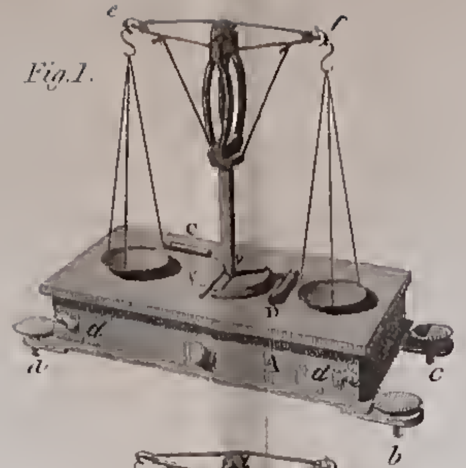


Fig. 2.

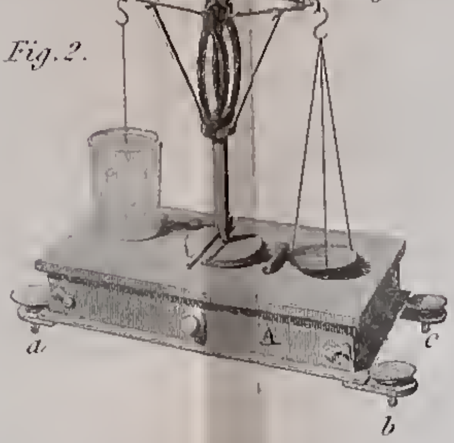


Fig. 3.

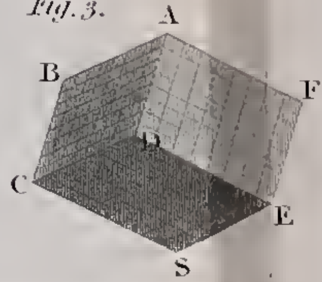


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

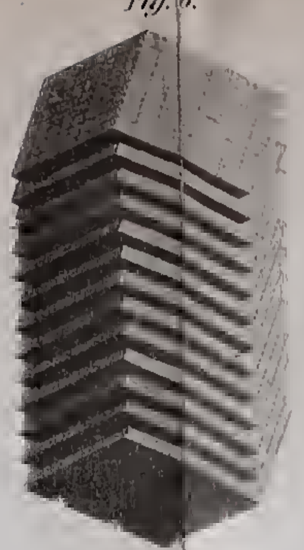


Fig. 9.

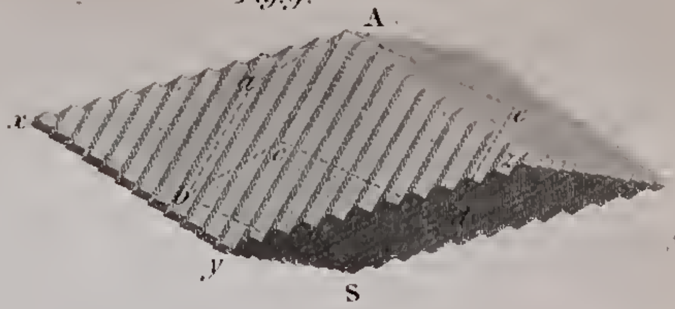


Fig. 10.

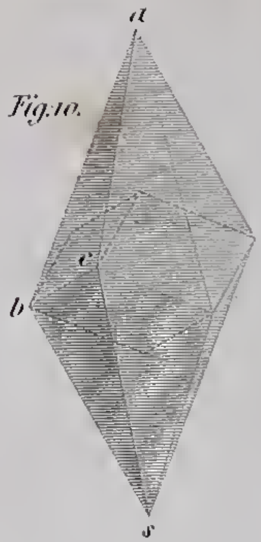


Fig. 11.

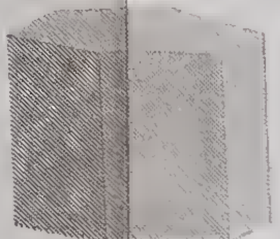


Fig. 12.

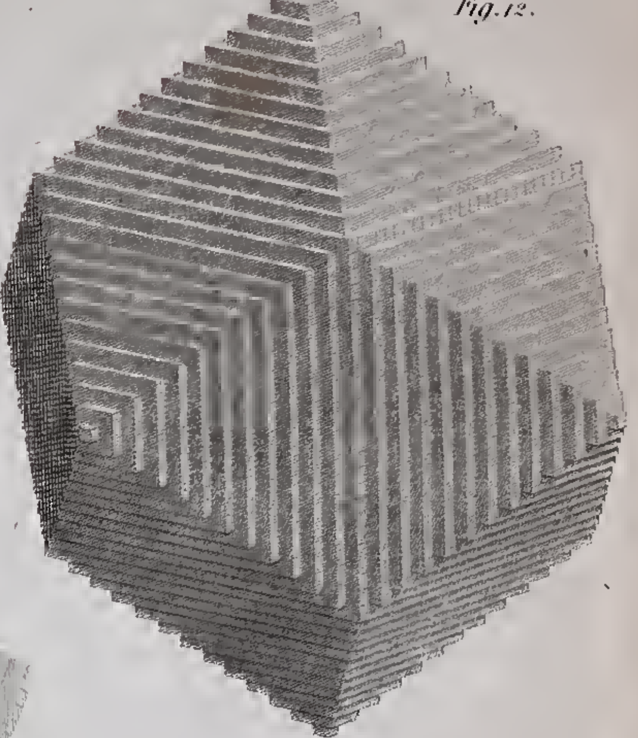


Fig. 13.

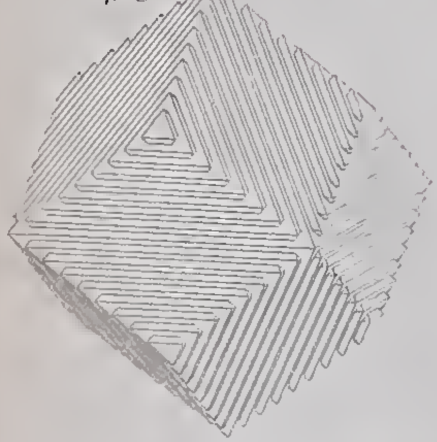


Fig. 14.

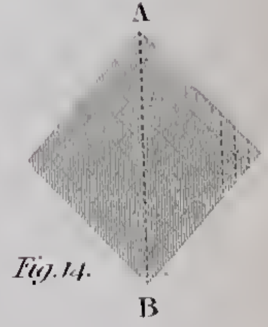


Fig. 15.

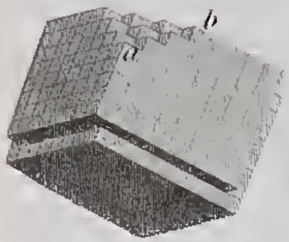
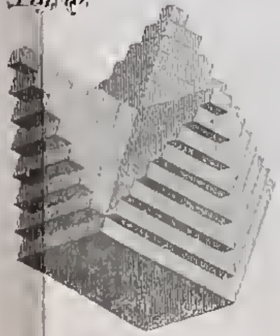


Fig. 16.



* Fig. 15.

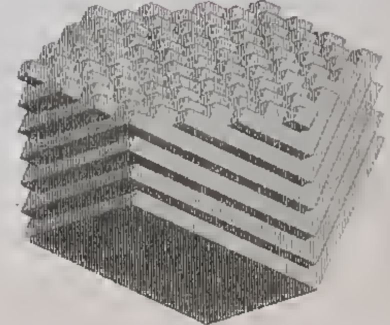
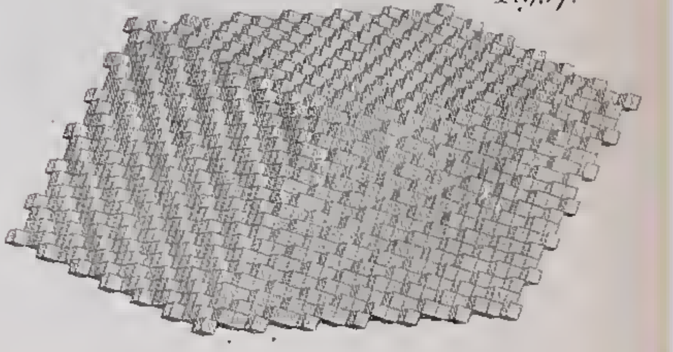


Fig. 17.

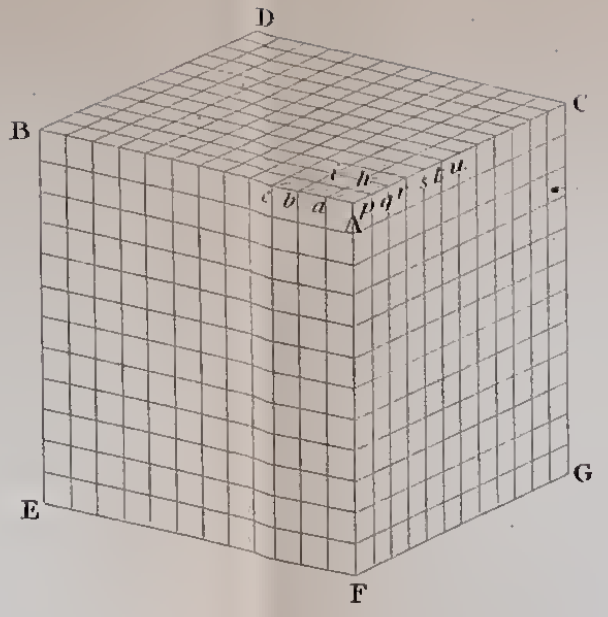


Drawn by Miss Lowry.

London, Published by Longman Hurst, Rees, Orme & Browne. 1822.

Engraved by W. & M

Fig. 18.



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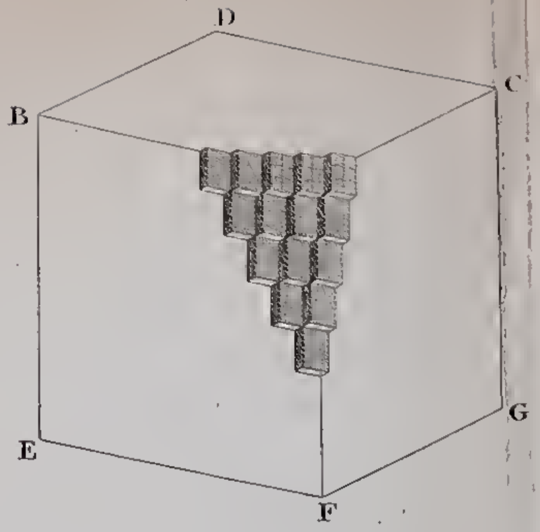

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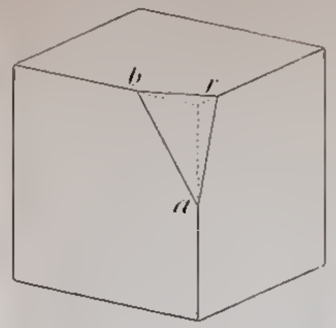

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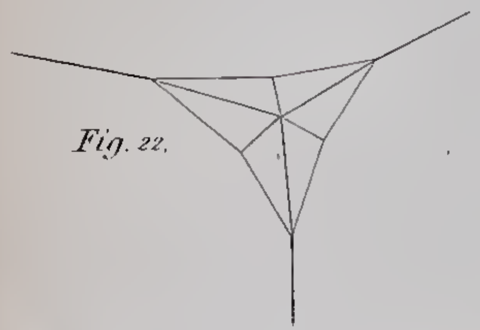
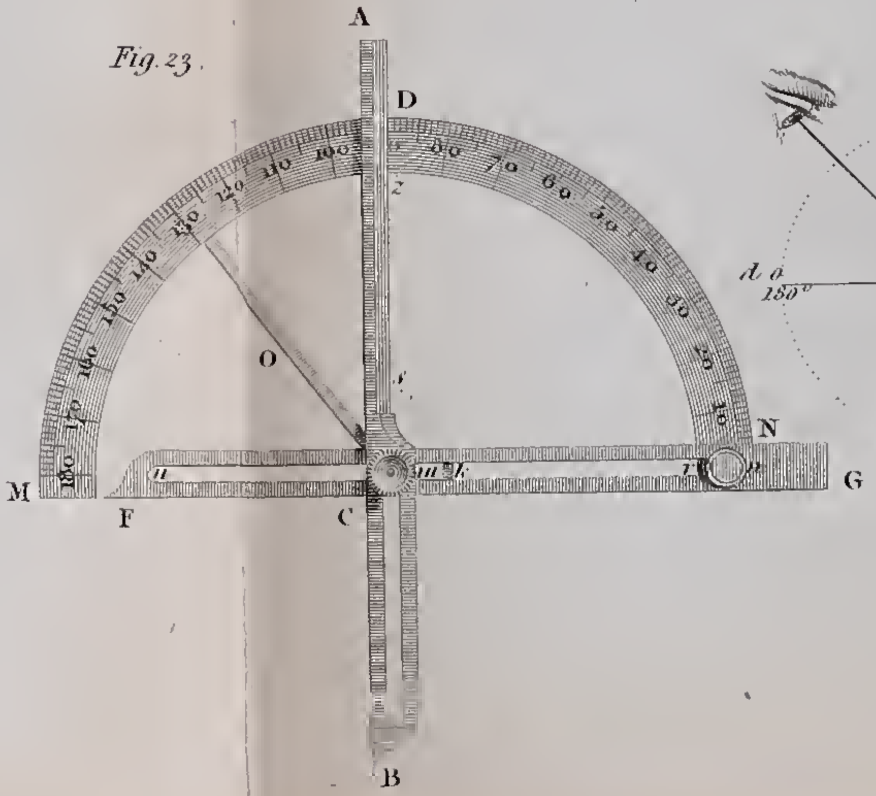


Fig. 22.

Fig. 23.



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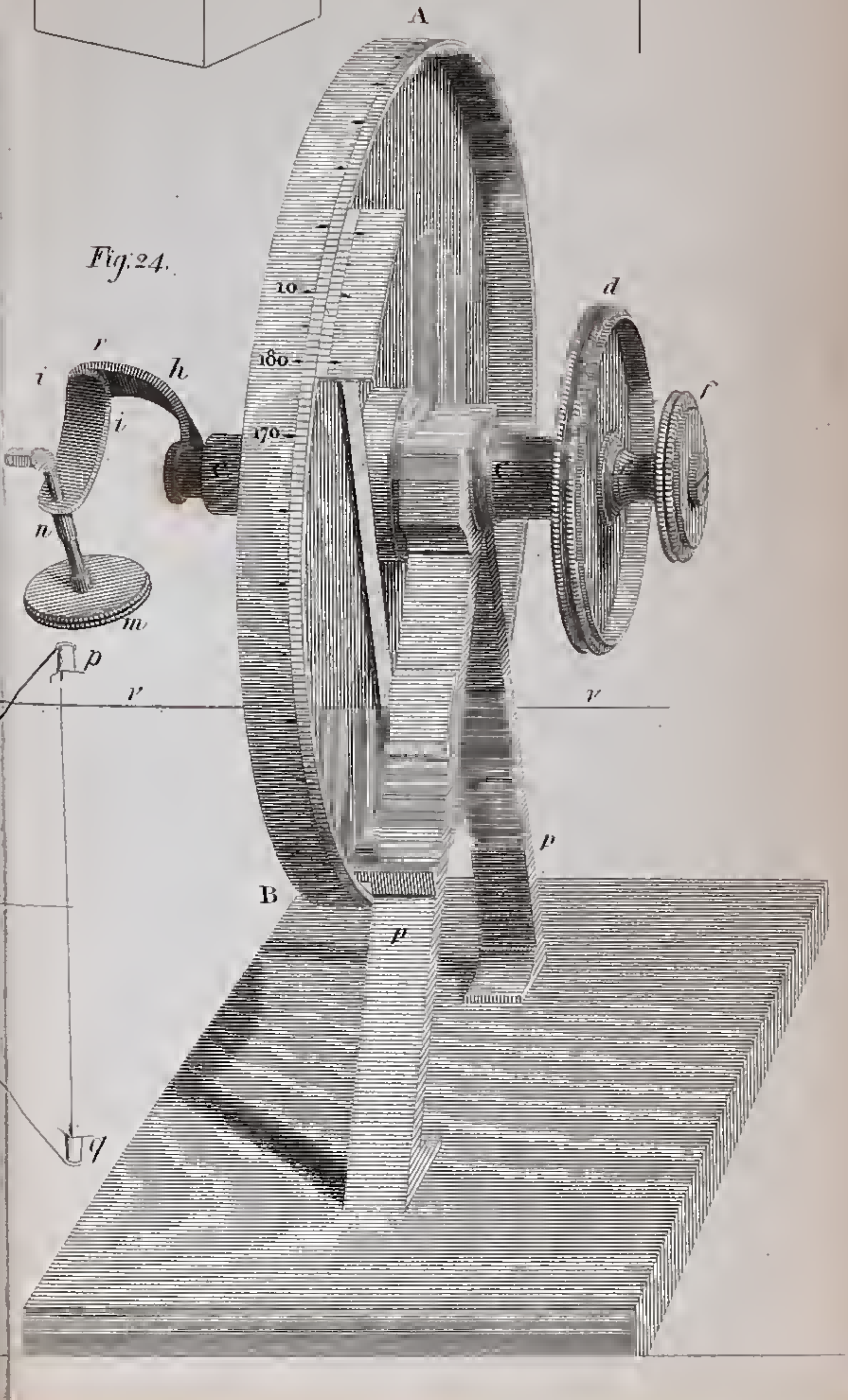

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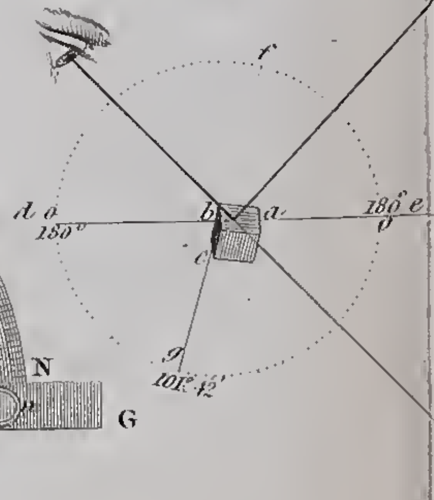

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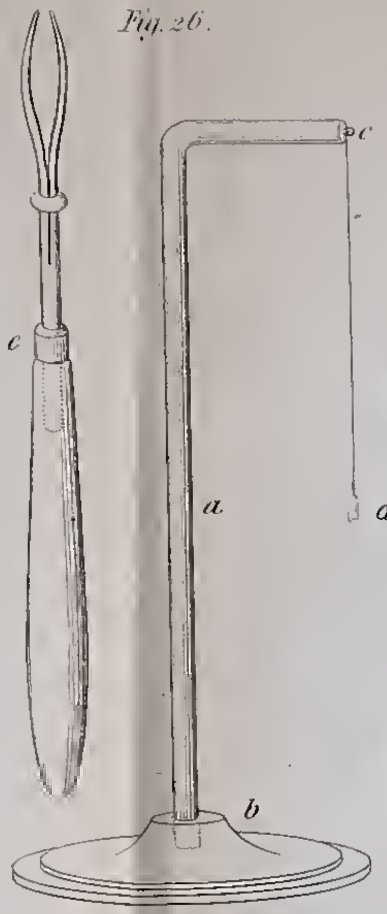

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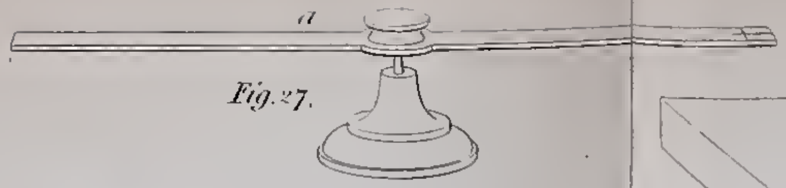

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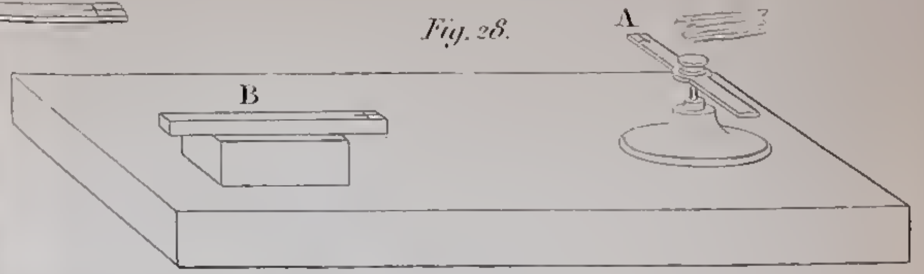

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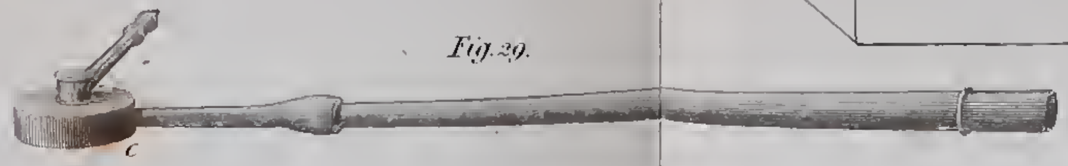

Fig. 30.

Fig. 31.

* 31.

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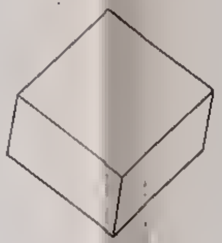

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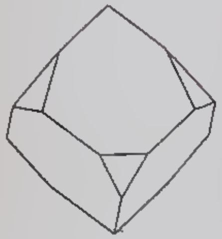

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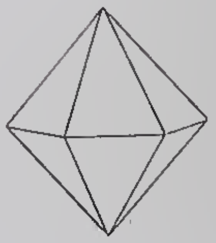

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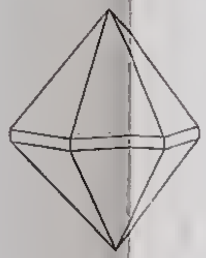

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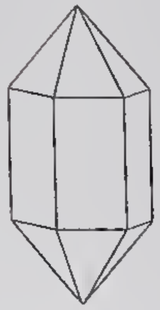

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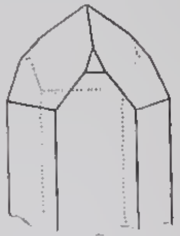

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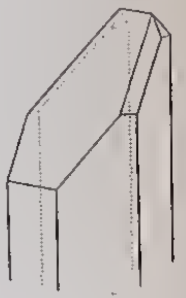

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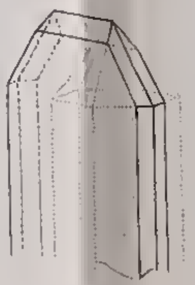

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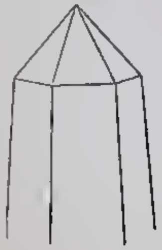

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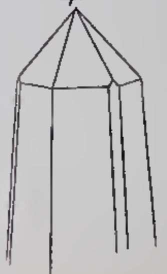

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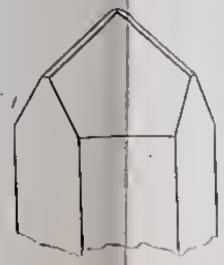

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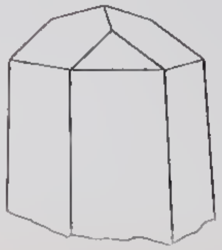

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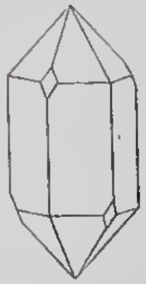

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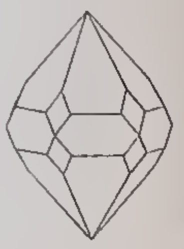
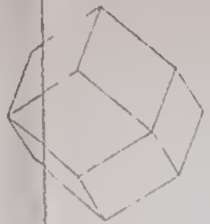
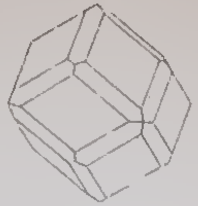


Hurst Rees Orme & Browne, 1822.

Engraved by R





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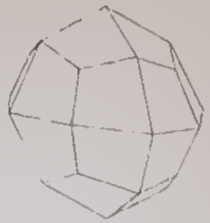

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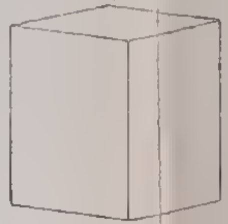

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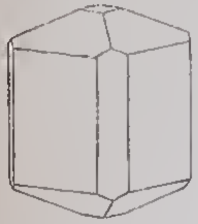

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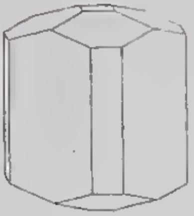

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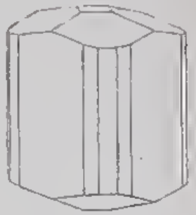

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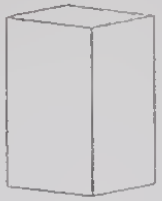

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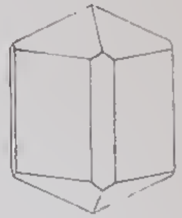

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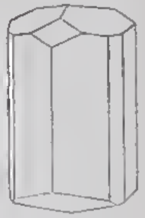

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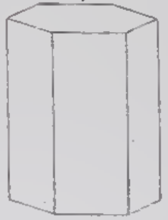

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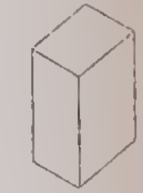

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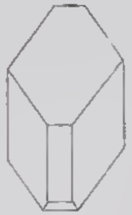

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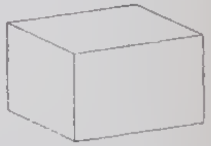

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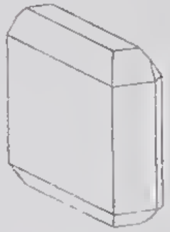

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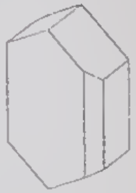

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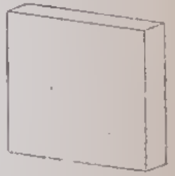

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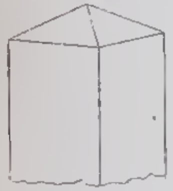

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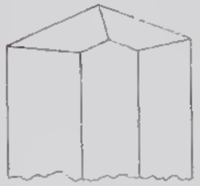

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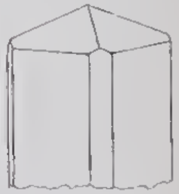

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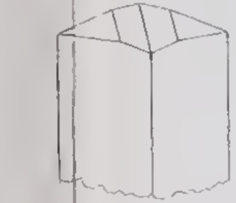

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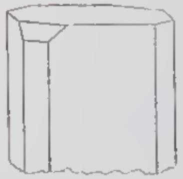

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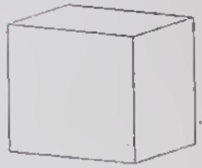

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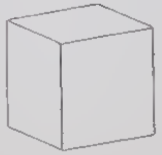

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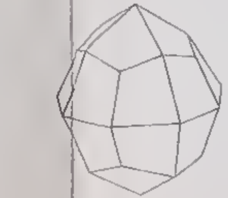

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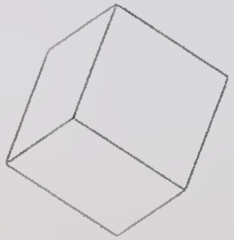

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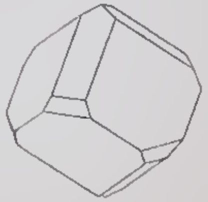

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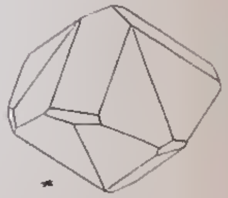

awn by Miſs Lowry.

London, Published by Longman, Hurst, Rees, Orme & Browne. 1822.

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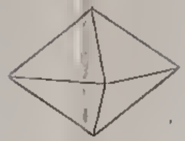
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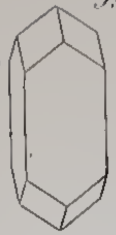
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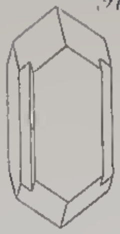
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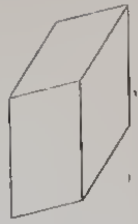
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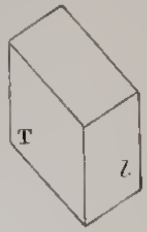
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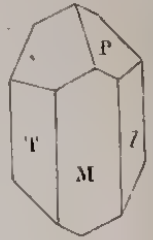
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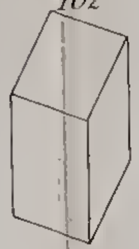
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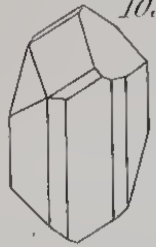
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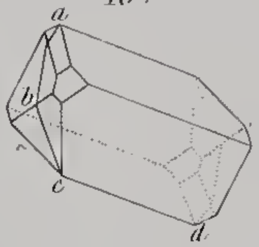
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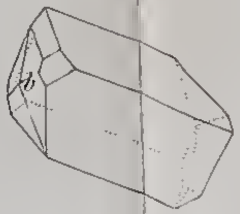
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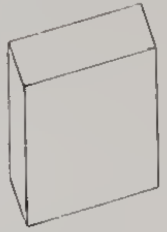
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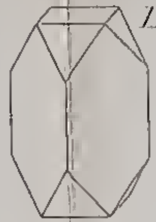
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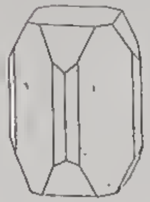
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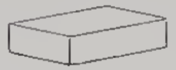
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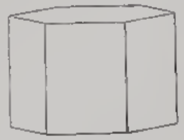
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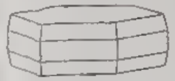
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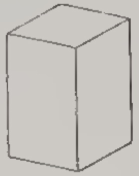
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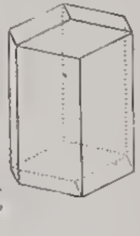
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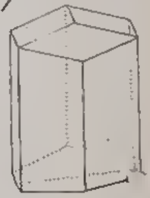
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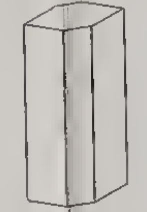
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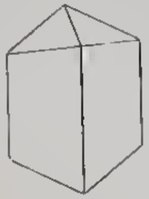
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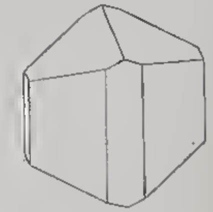
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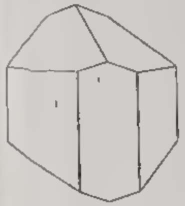
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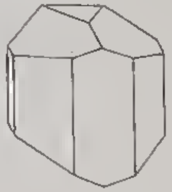
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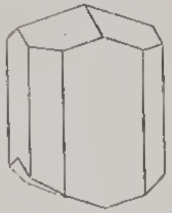
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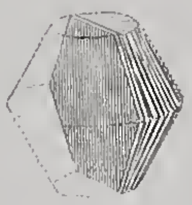
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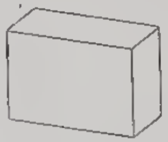
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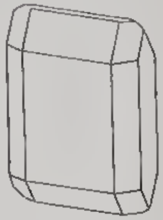
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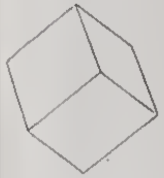
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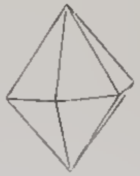
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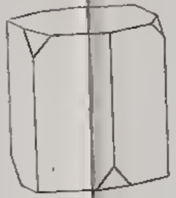
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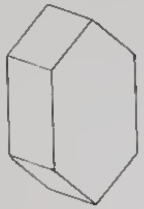
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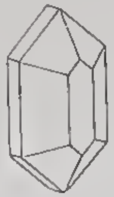
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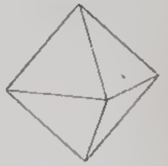
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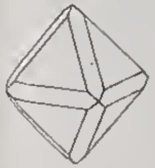
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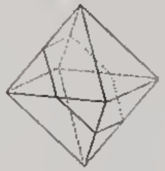
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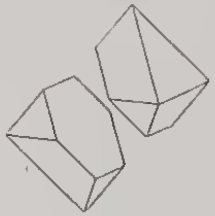
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